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Comparative Physiology. — *Die Eigenschaften glatter Tonusmuskeln, verglichen mit den Eigenschaften von unvulkanisiertem, plastiziertem Kautschuk.* Von H. J. JORDAN. (Uit het Laboratorium voor vergelijkende Physiologie van de R. U. te Utrecht.)

(Communicated at the meeting of June 27, 1936).

Der Tonus glatter Muskeln bei Tieren, deren neuro-muskuläre Organisation derjenigen von Hohlorganen gleicht, beruht auf dem visko-elastischen Zustand der Muskelsubstanz und wird von uns aufgefasst als Residuum einer „langsamen" oder „tonischen" Kontraktion. In diesem Zustand ist der Muskel mit einem kolloidalen Stoffe zu vergleichen, wie z.B. mit unvulkanisiertem, plastiziertem Kautschuk.

Der Tonus beruht hauptsächlich auf der Viskosität der Muskelsubstanz, die Anpassung an zunehmende Füllung des Schizozoels dahingegen auf passivem Nachgeben unter Ueberwindung des Widerstandes, den die Viskosität bietet. Hierbei ergibt sich eine Reihe von Erscheinungen, die bei Muskel und Kautschuk in gleicher Weise nachweisbar sind. Eine dieser Erscheinungen ist der „Schneepflugeffekt", das ist Erhöhung des Widerstandes während passiver Dehnung, die mit der Schnelligkeit ungefähr proportional ist, mit welcher der Innendruck (im Versuch die Last) den Muskel zu dehnen sucht.

Ich habe dieses Verhalten bei den Muskeln von Metridium dianthus beschrieben[1]), wo es eine sehr grosse Rolle spielt und den Muskel vor übertriebener Dehnung schützt. Wenn man nach Auftreten von Schneepflugeffekt den Muskel eine Zeitlang dem Einfluss der Last entzieht, dann erfolgt „Abfluss" des gesteigerten Widerstandes. Hierdurch erhält der Muskel seinen ursprünglichen Zustand zurück, was sich bei erneuter Belastung durch eine steile Strecke der Dehnungskurve („freier Fall") zu erkennen gibt; auf den „freien Fall" folgt in der Regel eine verhältnismässig kleine, ziemlich steile Strecke, die allmählich in, aufs neue durch Schneepflugeffekt sehr verminderte Neigung übergeht.

Man kann den Schneepflugeffekt durch folgende Versuche deutlich machen, bei denen man „fraktionierte Dehnung" anwendet: man dehnt den Muskel jeweils eine bestimmte Zeit mit hoher Last, um dann mit der Bremse unseres Apparates die beiden Enden des Muskels zu fixieren, so dass der Muskel dem Einfluss des Gewichtes entzogen ist. („Bremspause"). Sodann öffnet man die Bremse wieder. Bei unveränderter Last folgt auf die Bremspause eine ziemlich hohe Strecke „freien Falls". Wenn

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[1]) JORDAN, H. J. Archives Néerland. d. Zoologie **1**, pag. 1 (1934).

man nun aber nach einer Bremspause den Muskel mit einem geringeren Gewicht belastet, tritt überhaupt kein „freier Fall" auf, sondern eine rein horizontale Strecke. Wenn man diese Versuche mit der geringeren Last wiederholt, dann tritt eine sehr kleine Strecke „freien Falles" auf, die beim folgenden Male zunimmt usw., bis sich ein neues Gleichgewicht zwischen Muskelzustand und Last eingestellt hat und der Muskel sich prinzipiell wie vor der Verminderung der Last beträgt.

Auch bei teilweiser Entlastung nach langer Dehnung ohne Bremspausen gibt sich der Schneepflugeffekt zu erkennen. Erst tritt eine geringfügige Wiederverkürzung auf von z.B. 3.9 % (in einem Falle, Cutisstreifen von Holothuria). Die Kurve läuft sodann geraume Zeit horizontal um sich dann, unter Einfluss der Restlast, mit geringer Neigung wieder zu senken.

Ich habe nunmehr diese Versuche mit Kautschukstreifen wiederholt, die ich der Freundlichkeit von Herrn A. VAN ROSSEM, Direktor des „Rijksrubberdienst" zu Delft verdanke. Das Material[1]) ist 0.95 mm dick, nicht vulkanisiert und 30 Minuten lang plastiziert; die untersuchten Streifen sind 4.45 cm lang und 1.28 cm breit. Die Kurven von solchen Kautschukstreifen entsprechen denen am Muskel von Metridium (Fig. 1; auf Fig. 3

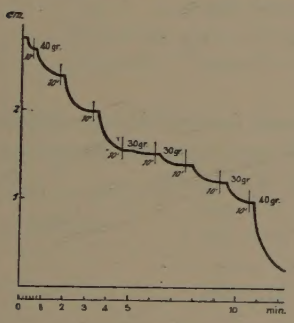

Fig. 1. Kautschukstreifen, fraktionierte Dehnung mit Pausen von je 10 Minuten (je bei 10'). Anfangsbelastung 40 gr, später 30 gr; am Schlusse wieder 40 gr. Man beachte das fast völlige Fehlen des „freien Falles" bei der ersten Belastung mit nur 30 gr und die Zunahme des freien Falles bei dreimaliger Wiederholung der Pause mit folgender Belastung mit 30 gr. Bei der Zeitmarkierung unterhalb der Kurve bleiben die Pausen in allen Figuren unberücksichtigt. In der Kurve sind die Pausen durch einen senkrechten Strich angedeutet. (Ordinatenschreiber nach N. POSTMA.)

am Schluss sieht man bei Kautschuk den horizontalen Kurventeil nach Entlastung in der oberen Kurve)[2]).

Die biologische Bedeutung des Schneepflugeffektes ergibt sich aus einer Vergleichung des Verhaltens zweier Ringpraeparate vom Mauerblatt von Metridium, von denen man das eine mit 30, das andere mit 5 gr belastet. Diese Versuche wurden durch Herrn P. J. KIPP ausgeführt.

Der Ring mit 30 gr dehnt sich zunächst schneller als der mit 5 gr. Nach kurzer Zeit vermindert sich die Dehnungsgeschwindigkeit hauptsächlich des erst genannten Ringes sehr, so dass beide Kurven nur noch wenig von einander abweichen, in manchen Fällen sogar parallel zueinander verlaufen. Nun wird in beiden Fällen eine Bremspause von 40 Minuten eingeschaltet; danach tritt bei dem Ring mit 30 gr, infolge des Abflusses des grösseren Schneepflugeffektes, eine grössere Strecke „freien Falles" und darauf folgend eine steilere Dehnung auf, als beim Ring mit 5 gr (Fig. 2).

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[1]) „F. L. crêpe (381)".

[2]) Siehe auch H. J. JORDAN, Verh. K. Akad. v. Wetensch. Natuurk. Amsterdam, D. 15 N°. 3, Chapter 6, p. 214, vor allem auf S. 239 ff. und 249.

TABELLE 1.

Metridium dianthus; Mauerblattring, ein Präparat mit 30 gr, das andere mit 5 gr belastet.

A.
1. Ordinatenverminderung durch Dehnung während der beiden letzten Minuten vor der Pause.

Last von 30 gr	4.5 mm
Last von 5 gr	4.5 mm
Unterschied	0.0 mm

2. Ordinatenverminderung durch Dehnung während der zwei ersten Minuten nach der „Bremspause" van 40 Minuten.

Last von 30 gr	27.5 mm
Last von 5 gr	16.5 mm
Unterschied	11.0 mm

B. (Fig. 2).
1. Ordinatenverminderung durch Dehnung während der zwei letzten Minuten vor der Pause.

Last von 30 gr	5.5 mm
Last von 5 gr	2.0 mm
Unterschied	3.5 mm

2. Ordinatenverminderung durch Dehnung während der zwei ersten Minuten nach der Bremspause von 40 Minuten.

Last von 30 gr	34.0 mm
Last von 3 gr	16.5 mm
Unterschied	17.5 mm

Vergrösserung des Unterschiedes durch die „Bremspause" um das 5-fache.

In einem Versuch betrug der Unterschied in der Ordinatenverminderung vor der Pause also 0 mm, nach der Pause 11 mm; in einem anderen (Fig. 2) vor der Pause 3.5 mm, nach der Pause 17.5 mm, so dass der Unterschied nach der Pause hier 5 mal so gross war als vor der Pause. Vor dem

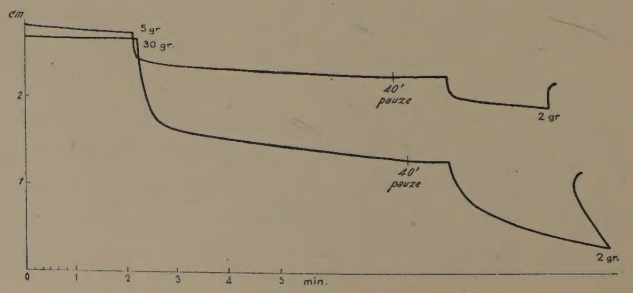

Fig. 2. Biologische Bedeutung des Schneepflugeffektes bei Metridium. Erklärung siehe Tabelle 1. Der Kurventeil nach partieller Entlastung ist nicht besprochen (bei der Marke „2 gr.") (Schreibhebel).

„Abfluss" durch die Pause hat der Schneepflugeffekt das grössere Gewicht, welches der eine Ring trug, fast oder ganz kompensiert. Sein Ausmass steht daher in der Tat in Beziehung zur Grösse der Kraft, mit der das Gewicht den Muskel zu dehnen sucht.

Ich habe diese Versuche mit Kautschuk wiederholt (Fig. 3) und hierbei einen Streifen mit 55, den anderen mit 40 gr belastet. Während einer

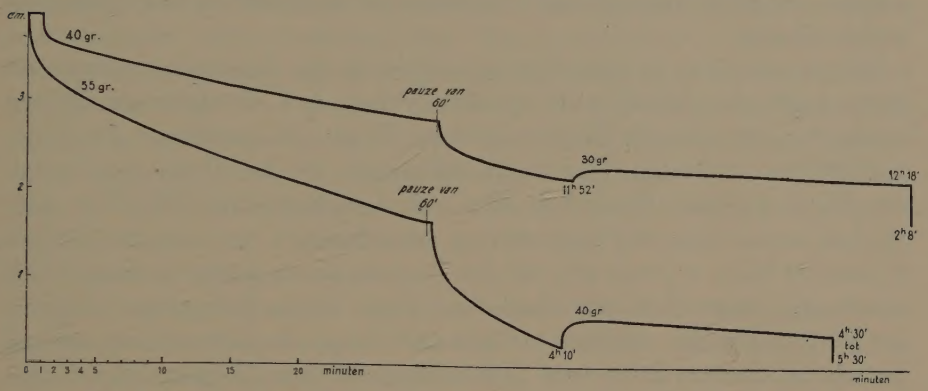

Fig. 3. Kautschukstreifen, gleicher Versuch wie der in Fig. 2 abgebildete; Erklärung siehe Tabelle 2. Um $12^h 18$ und $4^h 30$ (Wiederanfang der Dehnung) Trommel angehalten. (Ordinatenschreiber nach N. POSTMA.)

Dehnungsdauer von 10 Minuten vor der Pause, war der Unterschied in der Ordinatenverminderung 5 mm, während er nach der Pause bei gleicher Dehnungsdauer 30 mm betrug. Der Unterschied war daher 6 mal so gross geworden.

TABELLE 2. (Fig. 3.)

Kautschuk: ein Streifen belastet mit 55 gr, der andere mit 40 gr bei einer Temperatur von 17.4°.

1.	Ordinatenverminderung durch Dehnung während der letzten 10 Minuten vor der Pause.
Last von 55 gr	14 mm
Last von 40 gr	9 mm
Unterschied	5 mm
2.	Ordinatenverminderung während der ersten 10 Minuten nach einer „Bremspause" von 60 Minuten.
Last von 55 gr	53 mm
Last von 40 gr	23 mm
Unterschied	30 mm

Vergrösserung des Unterschiedes durch die Bremspause um das 6-fache.

Der „Abfluss" des Schneepflugeffektes steht in Beziehung zu einer Erscheinung, die man in der Kautschuktechnik „Relaxation" nennt. Die

während der Dehnung gespannten Teilchen ziehen sich während der Fixierung der beiden Enden des Kautschukstreifens zusammen, während sie den Widerstand des intermizellären Stoffes überwinden.

Derartige sich ausgleichende elastische Spannung muss auch bei dem Abfluss des Schneepflugeffekts eine Rolle spielen. Einen rein horizontalen Teil einer Dehnungskurve kann man nicht lediglich durch erhöhte Viskosität erklären, er weist vielmehr auf Wechselwirkung zwischen Spannung und Viskosität hin.

Wenn man einen Schneepflug schnell durch den Schnee zu ziehen versucht, häuft der Schnee sich vor dem Pfluge auf. Feinkörniger Schnee würde der Schwerkraft folgend in einer Pause, d.h. während der Ruhe des Pfluges, abfliessen. Der Intermizellarstoff, der bei Formveränderung von Muskeln oder Kautschuk den sich verschiebenden Mizellen ausweichen muss, kann das ebensowenig schnell genug tun, wie der Schnee in unserem Bilde; er häuft sich vor den Spalten, durch welche er ausweichen müsste an, unter Dehnung elastischer Teile, deren Relaxation während der Bremspause den Abfluss bewirkt und daher die Schwerkraft ersetzt, die wir in unserem Bilde vom Schneepflug für den Abfluss des Schnees verantwortlich machten.

Die glatten Muskeln unserer Objekte zeigen sehr deutlich Relaxationserscheinungen (Fig. 4), wie man sie bei Kautschuk kennt. Wenn man einen gedehnten Muskel total entlastet, so tritt Wiederverkürzung auf.

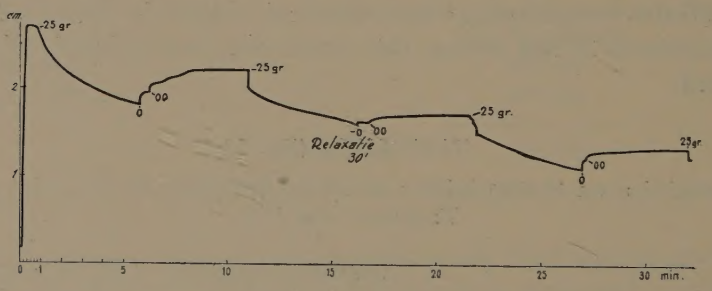

Fig. 4. Fuss von Helix pomatia; Relaxation. Erklärung siehe Tabelle 3. (Ordinatenschreiber nach N. POSTMA.)

Schaltet man aber nach einer gleichen Dehnung eine Bremspause von z.B. 30 Minuten ein, so wird diese Wiederverkürzung viel kleiner; durch längere Pause kann man sie zum Verschwinden bringen.

TABELLE 3. (Fig. 4.)

Fuss von Helix pomatia. Dekreszente nach Kontraktion durch Reizung mt R. A. 8.5 cm. Temperatur 17.8°, Last 25 gr. Rein tonische Dehnungskurve.

5 Min. Dehnung, Entlastung total in zwei Tempi: 0 und 00 gr. Zunahme der Ordinate	1.45 cm
5 Min. Dehnung, Relaxation 30 Min. Entlastung. Zunahme der Ordinate . .	0.42 cm
5 Min. Dehnung, keine Relaxation, Entlastung. Zunahme der Ordinate . .	0.88 cm

Bei der Dehnung derartiger kolloidaler Systeme gibt es noch eine weitere Form von Widerstandserhöhung, die vor allen Dingen bei Kautschuk gut bekannt ist, von der ich aber nicht weiss, ob sie bei allen Muskeln der von uns behandelten Arten vorkommt. Diese Widerstandserhöhung tritt auf nach Massgabe der Strecke um welche wir ein solches System dehnen. Bei Kautschuk erklärt man diese Erhöhung des Widerstandes durch den Umstand, dass die Mizellen im Laufe der Dehnung gleichgerichtet werden und einander näher kommen. Der Hauptunterschied zwischen dieser Widerstandserhöhung und dem Schneepflugeffekt ist zunächst der, dass der Schneepflugeffekt nicht von der Länge der Dehnungsstrecke, sondern von der Schnelligkeit, mit welcher die Last die Formveränderung durchzusetzen versucht, abhängt. Sodann ist nicht einzusehen, wie die Teilchen, wenn sie einander in weitgehenderem Masse anziehen, durch „Abfluss", ohne Energiezufuhr (Schrumpfung nur in der Wärme!) wieder in den losen Zustand übergehen sollten.

Der Schneepflugeffekt beschützt die Mauerblattmuskulatur von Metridium vor übermässiger Dehnung [1]) dadurch, dass die Dehnung mehr oder weniger plötzlich unterbrochen wird: es tritt die Erscheinung auf, die wir beim Fusse von Helix den „Umschlag" genannt haben. Bei Helix pomatia wird diese Widerstandserhöhung jedoch durch den regulierenden Einfluss der Pedalganglien erzeugt. Zwar kommt Schneepflugeffekt auch bei Helix vor, er ist aber lange nicht so stark wie bei Metridium und verursacht in der Regel keinen deutlichen Umschlag. Wenn man die Dehnungskurve eines Helixfusses, der im Besitze seines Tonuszentrums ist, mit der entsprechenden Kurve eines Fusses ohne Pedalganglien vergleicht, so dehnt der Fuss mit Ganglien sich erst viel schneller als derjenige ohne Ganglien. Später aber tritt bei jenem der „Umschlag" ein, sodass beide Kurven einander schneiden. Dass die plötzlich einsetzende Widerstandserhöhung des Umschlages hier kein Schneepflugeffekt ist, ergibt sich aus ihrem unmittelbaren Verschwinden nach Exstirpation der Pedalganglien.

Aehnliches gilt für SHERRINGTONS „stretch reflex", durch den der Widerstand von tonisch verkürzten Streckmuskeln der Wirbeltiere durch Zug an der Sehne erhöht wird. Auch hier verschwindet die Reaktion nach Durchschneidung des Nerven. Der vom Nervensystem isolierte Muskel verhält sich wie ein Stück nicht kontraktilen Gewebes, z.B. wie ein Stück Haut [2]).

Die kolloidalen Eigenschaften der sehr viskösen aber trägen Metridiummuskeln vertreten die zentralen Einflüsse bei Helix, im Zusammenhang mit der Tatsache, dass die Helixmuskeln weniger träge, aber auch weniger viskös sind.

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[1]) Eine solche würde z.B. auftreten, wenn die Aktinie bei Ebbe die Gewichtskompensation durch das Wasser verliert.

[2]) R. S. CREED, D. DENNY BROWN, J. C. ECCLES, E. G. T. LIDDELL and C. S. SHERRINGTON: Reflex Activity of the Spinal Cord, Oxford 1932.

Der Schneepflugeffekt ist ein Beispiel für eine Regulierung, die man „scheinbare Regulierung" nennen könnte. Denn die Anpassung an übertriebene Last geschieht hier nicht durch besondere regulierende Faktoren, die durch Erzeugung eines, vom physikalischen Standpunkte aus paradoxalen Verhaltens einen schädlichen Einfluss kompensieren [1]). Als Beispiel echter Regulierung denke man an die Atmung; Mangel an Sauerstoff oder Ueberschuss an Kohlensäure würden an sich die Tätigkeit aller Muskeln verminderen. Von dieser Regel sind auf paradoxale Weise gerade die Atmungsmuskeln und nur diese ausgenommen, deren Tätigkeit bei unzureichendem Gaswechsel zunimmt.

Hier kommen wir mit einfacher kausaler Beschreibung nicht aus. Wir müssen eine Vielheit von kausalen Erscheinungen auf ein bestimmtes Endresultat beziehen und bedürfen daher eines besonderen Begriffes, nämlich „Regulierung". Durch diesen Begriff erfassen wir das Spezifische der zusammenwirkenden Faktoren, also die kausalen Strukturen.

Die Erscheinungen am Kautschuk kann man vergleichen mit den Erscheinungen an einem Gasvolumen. Wenn man ein solches komprimiert, so wird es warm und erzeugt Widerstand gegen die Kompression, als ob es sich vor dieser schützen wollte. Auch das ist nur scheinbar eine Regulierung. Es fehlt jedes Paradoxon. Man kann die Erscheinungen beschreiben, ohne den Begriff der Regulierung zu gebrauchen, in einfacher kausaler Beziehung.

Durch den Schneepflugeffekt können wir die Zustandsänderungen der kolloidalen Strukturen unserer Muskeln während passiver Formveränderungen genau verfolgen. In einer folgenden Mitteilung werde ich die mit dieser Methode erzielten Resultate besprechen.

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[1]) Siehe „Der Begriff Regulation". S. 688 von H. J. JORDAN, Stoffwechsel (allgemeine und vergleichende Physiologie) Handwörterbuch der Naturwissenschaften, 2te Aufl. S. 676.

Medicine. — *Immunität gegen Gelbfieber bei weissen Mäusen.* Von W. A. P. SCHÜFFNER und B. WALCH—SORGDRAGER. (Aus dem Institut für Tropenhygiene, Abteilung des Königl. Kolonialen Institutes.)

(Communicated at the meeting of June 27, 1936).

Gelbfieber hinterlässt beim Menschen eine starke Immunität, die sich lebenslang erhalten kann (bis nach 78 Jahren nachgewiesen). Künstliche Methoden der Immunisierung, die bei Gelbfieber ebenso wie bei anderen Virus-Krankheiten nur durch lebendes Virus erreicht werden kann, geben viel geringere Grade der Immunität, jedoch immer noch so viel, dass die Schutzstoffe bis zu zwei Jahren nach erfolgter Impfung im Blute nachgewiesen werden können. Das gilt für den Menschen ebenso wie für den

Rhesus-Affen, der sich gegenüber Gelbfiebervirus dem Menschen ziemlich gleich verhält. Weniger bekannt ist die Reaktion der weissen Maus, gegenwärtig das Versuchstier der Wahl. Erfahrungen in unserem Institut schienen darauf hin zu weisen, dass die Maus, die eine Impfung mit Gelbfieber überstanden, eine viel geringere, ja, wie aus dem folgenden hervorgeht, überhaupt keine Immunität entwickelt. In einer Zeit nämlich, wo im hiesigen Institut grosser Mangel an frischen weissen Mäusen herrschte, und wo es doch nötig war, die Gelbfieberstämme durch regelmässiges Ueberimpfen zu erhalten, wurden, wie sich später herausstellte, auch Tiere herangezogen, die eine Infection bereits überstanden hatten. Diese Tiere erlagen der intrazerebralen Impfung genau so, wie frische Mäuse. Das Resultat kam uns einigermassen unerwartet, stellte aber zugleich die Aufgabe, den Prozess der Immunisierung bei der Maus genauer zu verfolgen. Ueber die zu diesem Zwecke vorgenommenen Untersuchungen soll hier berichtet werden.

Als Material dienten alle die Mäuse, die bei den Versuchen in der einen oder anderen Weise Gelbfiebervirus erhalten hatten, aber mit dem Leben davon gekommen waren. Dazu gehörten:

A. die Tiere, die nach der Methode von THEILER vorbehandelt waren, von uns die *directe* Methode genannt. Hierbei wird den Mäusen eine kleine Menge (0.02 cc.) [1]) eines Virus-Serum-Gemisches direct in das Grosshirn eingespritzt; es kommt also unmittelbar auf den Platz, wo es eventuell seine Wirksamkeit entfalten kann.

War das Serum frei von Schutzstoffen, dann entwickelte sich eine Encephalitis, die binnen 6—7 Tagen den Tod der Maus nach sich zog. Im anderen Fall, d.h. also wenn das Serum Schutzstoffe enthielt, wirkte dieses neutralisierend auf das Virus, machte es unwirksam, und die Maus blieb am Leben.

Will man diese Methode fein einstellen, dann ist es nötig, das Virus vorher zu titrieren, um die minimale letale Dosis zu bestimmen. Diese Forderung ist in der Praxis schwer zu erfüllen, wie THEILER selbst bekennt; auch in unserem Institute kommen wir zu dem gleichen Schluss. Eine Zeit lang hofften wir, durch Trocknen des titrierten Virus die Dosis constant halten zu können. Die Resultate damit waren aber, von THEILER ebenso wie von uns gefunden, so wenig feststehend, dass wir von dem Gebrauch getrockneten Virus [2]) für diesen besonderen Zweck wieder absahen. Doch haben wir, im Gegensatz zu anderen Instituten, die directe Methode beibehalten.

Wir nehmen als Virus die Verdünnung einer Gehirnemulsion von 1 : 10000, die durch ein Seitzfilter gesogen wird. Filtrieren ist nötig, um auch die kleinsten Zellbrocken zurück zu halten, die das Virus der

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[1]) THEILER nahm 0.03 cc.

[2]) Dass uns übrigens das Trocknen des Virus grosse Vorteile gegeben hat, geht daraus hervor, dass wir Proben besitzen, die 4 Jahre ihre Infectionskraft bewahrt haben.

Wirkung des Immunserums entziehen und damit den Versuch unbrauchbar machen könnten (DINGER). Doch selbst mit dieser Vorsorge fällt das Resultat nicht einwandfrei aus, weil man nicht weiss, ob und wieviele tötliche Dosen in der Verdünnung 1 : 10000 enthalten sind; sie können zwischen 1 und 100000 schwanken, entsprechend dem jeweiligen Gehalt an Virus in den gebrauchten Mäusegehirnen.

Dem Virus-Serum Gemisch gibt man gewöhnlich eine halbe Stunde Zeit zur Bindung. Nach Versuchen von KOTTER an unserem Institut könnte man mit viel kürzerer Zeit auskommen. Die Bindung scheint etwa im Verlauf einer Minute abzulaufen. Nur wenn man die Mischung in der Spritze vornimmt, und dann unmittelbar einspritzt, kann man erwarten, noch wirksames Virus zu geben, d.h. also trotz Anwesenheit von Immunserum die Maus krank zu machen. Bei einer halben Stunde hat man daher vollste Sicherheit.

B. die Tiere, die nach der Methode von SAWYER, von uns die *indirecte* genannt, vorbehandelt waren. Man giebt hier das Virus-Serum-Gemisch intraperitoneal und ausserdem ins Grosshirn eine minimale Injection von einer 2 % gekochten Stärkelösung. Damit setzte SAWYER einen locus minoris resistentiae im Gehirn, ein Eingriff, der an sich gut vertragen wurde. Gelangt nun Virus auf dem Wege der Blutbahn vom Abdomen aus in diesen Herd, dann entwickelt sich die Encephalitis wie bei directer Impfung, mit kaum merkbarer Verzögerung (6—7 Tage).

Für diesen Versuch verwendet SAWYER eine viel grössere Virus-Dosis, 0.2 ccm. einer 20 % (wir nur 10 %) Gehirnemulsion schwer kranker Mäuse; das ist circa 20000 mal mehr als bei der directen Methode. Ausserdem wird die Emulsion nicht filtriert, die Mäuse erhalten also nicht nur Virus im freien Zustande, das durch das gleichzeitig gegebene Immunserum sofort gebunden werden könnte, sondern auch Virus, noch eingeschlossen in Zellteilchen. Hierin kann sich das Virus viel länger lebend erhalten, vielleicht vermehren, in die Blutbahn gelangen, um erst nun von dem inzwischen aus der Bauchhöhle resorbirten Immunserum unschädlich gemacht zu werden. Dieser Prozess verläuft gereckter, es ist dabei eine zeitweilige, sei es auch noch so kurze Virämie vorhanden, die Tiere machen also eine refractäre Infection durch und bleiben am Leben. Wie sich das auswirkt, folgt später.

C. Ausser den Mäusen, die ihr Leben nach einer Gelbfieber-Infection dem gleichzeitig gegebenen Immunserum verdankten, ist noch eine dritte Gruppe zusammengestellt von solchen, die trotz Fehlens von Immunstoffen der Infection nicht erlagen. Meistens wird es sich um Tiere gehandelt haben, die eine subletale Dosis Virus erhielten, also solche, die eine wirkliche Infection durchmachten. Andere erhielten nur die peritoneale

Virusinjection, ohne Gehirnläsion. Endlich brachten wir hier solche Mäuse unter, die erst 10—14 Tage nach der Gehirnläsion intraperitoneal geimpft wurden.

D. Als letzte Gruppe folgen die Mäuse, die eine zweite Impfung überstanden hatten, und nun bei einer dritten Impfung die Frage beantworten konnten, ob die Nachimpfung noch einen weiteren Einfluss auf den vorher gefundenen Zustand gehabt hatte.

Die Anordnung der Versuche.

Obwohl der negative Ausfall der eingangs erwähnten Durchimpfungen (zur Erhaltung des Stammes) wenig Aussicht auf Aufschluss über die Immunität gab, wurde doch die *directe* Nachimpfung in den Versuch hereinbezogen. Von den ersten 28 intrazerebral nachgeimpften Tieren aber blieb keines am Leben. Bei fortgesetzten Versuchen kamen zwar einzelne Ausnahmen zur Beobachtung, das änderte jedoch wenig an dem Resultat, wonach die directe Methode so gut als keine Immunität bei unsern überlebenden Mäusen feststellen konnte. Wir gaben daher diesen an sich einfachsten Weg vorläufig auf, vor allem, als wir sahen, dass sich das Bild mit der indirecten Methode vollkommen änderte.

Diese Erfahrungen haben uns mit bestimmt, den Factor einer gegenüber Gelbfieber resistenten Mäuserasse hier ausser Acht zulassen, umso mehr, als uns bei unseren jahrelangen Arbeiten eine für Gelbfieber wenig oder nicht empfängliche Mäuserasse nicht begegnet ist. Von amerikanischen Untersuchern wird auf das Vermeiden solcher Rassen grosser Wert gelegt, doch ist nicht bekannt, dass man systematische Untersuchungen in dieser Richtung angestellt hätte, z.B. mit Züchten solcher resistenter Rassen. Unerwartetes am-Leben-bleiben einer Controlgruppe, besonders bei SAWYERscher Impfung, konnten wir besser auf ungenügende Dosierung des Virus zurückführen, ohne den Tatsachen Gewalt anzutun. Diese Unregelmässigkeit kam bei unsern Versuchen eher einmal vor, da wir bei der SAWYERschen Methode bei der 10 prozentigen Gehirnemulsion geblieben sind, die SAWYER ursprünglich angab, jetzt aber auf 20% gebracht hat. Die Emulsion wird bei uns sogar noch schwach centrifugiert, um die gröbsten Partikel auszuschalten. Dies geschieht, um schwache Immunität durch Uebercompensation nicht zu übersehen. Kleine individuelle Unterschiede in der Empfänglichkeit, die bei Mäusen ebenso wie bei Menschen vorkommen, aber etwas anderes sind als resistente Rassen, haben auf den Ausfall der Versuche, soweit wir urteilen können, keinen merkbaren Einfluss gehabt.

Eine Erklärung dieses negativen Resultates ist durch folgende Gedankengänge möglich. Das Gehirn der Maus konnte für eine Ueberdosierung des Virus empfindlich sein. Um das zu vermeiden, müsste man die kleinste letale Dosis geben. Wir haben aber oben schon darauf hingewiesen, wie zeitraubend und unsicher die Feststellung des Titers ist.

Meistens giebt man daher eine zu hohe Dosis, die Mäuse, obwohl vielleicht immun, erliegen der Infection, und nur ausnahmsweise bleibt eine am Leben, bei der zufällig der Grenztiter getroffen wurde.

Eine andere Erklärung liesse sich aus der auch bei anderen Viruskrankheiten bekannten Eigenschaft der Gehirnzellen ableiten, keine oder

nur geringe Immunität anzunehmen. Das direct eingespritzte Virus würde dann sofort einen Boden finden, auf dem es ohne Widerstand haften und eine tötliche Infection einleiten könnte. Für die in dieser Reihe in Betracht kommenden Mäuse, d.h. also solchen, bei denen nur eine einmalige Infection vorausging, scheint uns diese Erklärung in der Tat die beste zu sein. Sie gilt aber nicht absolut, denn nach einer zweiten Nachimpfung (s. unten) widersteht ein grosser Teil der Mäuse der intrazerebralen Infection.

Der grosse Rest der Mäuse wurde mit der indirecten Methode nachbehandelt. Von 265 zeigten sich 121 oder 46 % der Mäuse der Infection gewachsen, während die gleichzeitig angesetzten Controlen mit wenig Ausnahmen starben. Damit war erwiesen, dass auch Mäuse Immunität erwerben können, und dass das negative Resultat bei intrazerebraler Nachimpfung, der Methode zuzuschreiben war.

Die indirecte Methode zeigte sich damit als die Ueberlegenere. Noch deutlicher kommt dies zum Ausdruck, wenn man das Mäuse-Material in zwei Gruppen teilt, eine, bei der die erste Infection nach der directen Methode, und eine andere, bei der sie nach der indirecten Methode geschah. Für die erste Gruppe 123 ergibt sich dann ein Ueberleben von nur 13 oder 11 %, für die zweite von 142 Tieren ein Ueberleben von 108 oder 76 %. Die beiden Gruppen sind, wie wir später fanden, nicht ohne weiteres zu vergleichen. Beschränken wir uns aber auf die Tiere, die nach ihrer einheitlichen Art der Vorbehandlung mit Gelbfieber verglichen werden dürfen, nämlich Tiere, die zweifelsohne Immunserum mit dem Virus erhielten, dann blieben von 43 resp. 67 Tieren 15 % resp. 70 % am Leben (statt 11 % und 76 %). Auch dann ist der Unterschied noch sehr ausgesprochen.

Wenn wir zurück greifen auf das, was über die Vorgänge bei den verschiedenen Impfmethoden gesagt wurde, dann ist das Resultat leicht begreiflich. Bei der directen Methode, wobei Virus und Serum eine Zeitlang der Bindung überlassen wurden, bleiben die Mäuse am Leben, wenn das Serum Immunstoffe enthielt und so das Virus unschädlich machen konnte. Abgetötetes Virus aber hat keine antigenen Eigenschaften (GORDON und HUGHES), es entwickelt sich daher bei den so behandelten Mäusen keine Immunität, resp. nur in den 11 %, wo der Zufall doch noch Spuren Virus ins Gehirn brachte.

Von der 2. Gruppe der Mäuse dagegen, die eine indirecte Impfung überlebten, erreichen ¾ eine Immunität, die sich hier auf dem Boden der eben besprochenen Virämie, resp. einer leichten Infection bilden kann. Dass die Dauer sowie die Lebhaftigkeit des Prozesses auf die Höhe der Immunitätskurve einen Einfluss hat, wird bei weiterem Auseinanderziehen der letzten Gruppe wahrscheinlich. Werden nämlich abgesondert, 1. die Mäuse, die Virus und Immunserum (67), 2. die, welche ein zweifelhaftes Serum (16), und 3. die, welche ein Normalserum, m.a.W. nur Virus (18) erhalten hatten, dann steigt der Prozentsatz der Ueberlebenden von 70 auf

81 und auf 100 %. Oder fügen wir zu den letzten 18 noch die hierhergehörige Gruppe unter C, die auch nur Virus erhielt, und wo von 33 Mäusen 30 überlebten, dann zeigt sich, dass von insgesammt 51 nachgeimpften Mäusen 48 oder 94 % die Impfung überstanden, und dies dank einer Immunität, die sie bei erster Infection mit Virus allein, sei es auch einer schwachen Dosis, gewonnen hatten. Die überlegene Wirkung der reinen Virusinfection gegenüber einer Simultanimpfung mit Immunserum tritt durch diese Zahlen (70 gegen 94) deutlich zu Tage; vor allem aber, dass auch die Maus die Fähigkeit besitzt, sich gegen Gelbfieber kräftig zu immunisieren.

Eine Fortführung der Versuche gestatteten die Mäuse, welche die hier besprochene Infection überstanden hatten. Sie hatten bei dieser 2. Infection sämmtlich ausschliesslich Virus erhalten. In der Annahme, dass wir es hier mit einem qualitativ verschiedenem, viel stärker behandeltem Material zu tun hatten, schien es aussichtslos, mit der indirecten Methode zu arbeiten, die schon bei Nachimpfungen bis 94 % positiven Ausschlag gegeben hatte. Wir griffen darum wieder auf die directe Methode zurück, um zu sehen, ob sie nun vielleicht am Platze war. Und in der Tat ergab sich jetzt ein anderes Resultat, von 67 Mäusen waren es 42, die bei der dritten Impfung am Leben blieben, oder 63 %, ein positives Ergebnis, das zu den vereinzelten überlebenden Mäusen der allerersten Reihe im scharfen Gegensatz steht.

Die Zahlen sind gross genug, um daraus folgern zu dürfen, dass bei Mäusen die Immunität durch eine Wiederimpfung in die Höhe getrieben wird. Durch Teilung des Materials, ebenso wie oben, in Mäuse, die bei erster Impfung Virus-Immun-Serum und in solche, die nur Virus erhielten, lässt sich selbst bestätigen, was wir über den Einfluss der Impfmethode gefunden hatten. Bei der ersten Gruppe von 38 sinkt dann der Prozentsatz der Ueberlebenden nach der 3. Impfung auf 47, durch den hemmenden Einfluss des Immun-Serums bedingt, bei der zweiten, von 29 mit 24 Ueberlebenden, steigt er auf 83. Die kräftiger immunisierende Wirkung von Virus allein wird daher auch hier deutlich.

Der nächste Schritt wird nun sein, ob sich im Gehirnsaft, der dann natürlich frei von Blut sein müsste, Immunkörper werden nachweisen lassen. Ueber diese Versuche soll später berichtet werden.

Das Resultat, das hier an Mäusen gewonnen wurde, steht im gewissen Gegensatz zu Versuchen, die Wray Lloyd und A. Mahaffy mit Affen vornahmen. Sie fanden, dass bei diesen Tieren eine wiederholte Impfung mit neurotropem Virus keine Erhöhung des Serumtiters zur Folge hatte. Dagegen konnte Whitman bei Kaninchen durch eine Wiederimpfung den Serumtiter stark erhöhen. Ueber das Verhalten des Menschen ist bisher noch nicht viel bekannt geworden. Falls die Erfahrungen, die wir an Mäusen machen konnten, als Aeusserungen biologischer Gesetzmässigkeiten aufgefasst werden dürften, dann würde auch beim Menschen eine Methode der Immunisierung mit Virus, das seiner Gefahren entkleidet sein müsste,

ZUSAMMENSTELLUNG.

Erste Nachimpfungen mittels der *indirecten* Methode von Mäusen, die eine Gelbfieber Infection überstanden hatten.

	Anzahl	Bei Nachimpfen bleiben leben	%
I. Nach directer Impfung (THEILER)	123	13	11
II. Nach indirecter Impfung (SAWYER)	142	108	76
1) Mit Virus + Immunserum	67	47	70
2) Mit Virus + zweifelhaftem Immunserum	16	13	81
3) Mit Virus + Normalserum	18	18	100
4) Allein mit Virus	33	30	91
3) und 4) zusammen	51	48	94

Zweite Nachimpfung, jetzt mit der *directen* Methode, von Mäusen, die nach den vorausgegangenen Versuchen übrig geblieben waren.

Davon erstmalig infiziert	67	42	63
a) Mit Virus + Immunserum	38	18	47
b) Mit Virus allein	29	24	83

den Vorzug verdienen. Vor allem aber würde eine zweimalige Impfung, wobei die zweite Impfung jedenfalls nur aus einer Virusgabe bestehen müsste, zur Steigerung der Immunität erwünscht sein.

ZUSAMMENFASSUNG.

Auch weisse Mäuse werden nach einer Gelbfieberinfection unempfänglich gegen eine zweite Infection, jedoch erfordert der Nachweis der Immunität das Einhalten eines besonderen Untersuchungsganges. Mittels der directen, intrazerebralen Nachimpfung erhält man nur dann einigermassen brauchbare Resultate, wenn es sich um Mäuse handelt, die eine wiederholte Infection hinter sich hatten. Bei einmaliger Infection deckte sie nur vereinzelt, und zwar allein bei Mäusen, die eine ausschliessliche Virusimpfung überstanden hatten, eine Immunität auf.

Weit regelmässiger liess sich eine vorhandene Immunität ermitteln durch intraperitoneale Impfung bei gleichzeitiger Gehirnläsion (indirecte Methode, nach SAWYER). Hierbei blieben von 265 Mäusen 121 am Leben oder 46 %.

Von den 265 hatten 123 Mäuse die directe Impfung gleichzeitig mit Immunserum durchgemacht (nach THEILER). Hiervon überlebten die

Nachimpfung, d.h. waren immun, nur 13 oder 11 %. Die directe Simultanimpfung giebt daher nur ausnahmsweise Gelegenheit zur Bildung einer Immunität.

Der Rest von 142 Mäusen hatte die indirecte Impfung durchgemacht. Hiervon überlebten die Nachimpfung, d.h. waren immun 108 oder 76 %. Darnach zu urteilen, führt die indirecte Methode sicherer zu einer Immunität. Werden hiervon 134 Mäuse in Gruppen verteilt, die *a*) Virus und Immunserum simultan, *b*) Virus und zweifelhaftes Serum, und *c*) Virus allein oder mit Normalserum empfingen, dann stellte sich die Immunität bei den entsprechenden Gruppen auf 70 %, 81 % und 94 %. Demnach giebt Virus allein die meiste Aussicht auf das Erwerben einer Immunität.

Die bei diesen Versuchen Ueberlebenden wurden nun nochmals einer Infection unterworfen. Bei dieser dritten Infection wählten wir wieder den directen Weg. Es überlebten von 67 Mäusen 42 oder 63 %, die Methode war hier also brauchbar und ein besserer Indicator als die indirecte, die schon nach einmaliger Impfung Ausschläge bis nahe 100 % gegeben hatte also höhere Werte nicht mehr anzeigen konnte. Wahrscheinlich ist die zweite Impfung im Stande, auch die Gehirnzellen zu immunisieren. Auch hier war bei den Mäusen, die erstmalig Immunserum gehabt hatten, der Prozentsatz der Immunisierten kleiner, nämlich 47 % gegen 83 % bei denen, die auch das erste Mal allein Virus erhielten.

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Physics. — *On the scattering of neutrons in matter.* (I). By Prof. L. S. ORNSTEIN. (Communication from the Physical Institute of the University of Utrecht).

(Communicated at the meeting of June 27, 1936).

In this paper I will discuss the statistics of the scattering of neutrons by an assemblage of protons (e. g. layers of paraffin) or nuclei. The collision of a neutron can be treated with the help of the theorem of conservation of energy and momentum. We will deal with collisions where the velocity of the neutron is large compared with that of the protons — this will generally be the case as long as not many collisions have occurred. If we assume that the velocity of the neutron forms an angle ϑ with the normal at the collision, we get for the case that the velocity of the proton is zero for the energy of the neutron after one collision:

$$\varepsilon_1 = \varepsilon_0 \sin^2 \vartheta.$$

ε_0 being the original energy of the neutron.
The probability of the mentioned collision is

$$2 \sin \vartheta \cos \vartheta \, d\vartheta$$

which can be transformed into

$$\frac{d\varepsilon}{\varepsilon_0}$$

for the probability of the energy after the collision between ε and $\varepsilon + d\varepsilon$, the whole range of energy being 0 to ε_0.

The mean value of the energy after one collision is thus $\frac{\varepsilon}{2}$, the mean value of the p^{th} power is

$$\overline{\varepsilon_1^p} = \frac{1}{p+1} \overline{\varepsilon_0^p}.$$

We will now deduce the probability of an energy between ε and $\varepsilon + d\varepsilon$ after n collisions, which we shall represent by $W_n(\varepsilon)\, d\varepsilon$. Now it is easy to indicate a recurrent expression for the probability mentioned; it is:

$$W_n(\varepsilon) = \int_{\varepsilon}^{\varepsilon_0} \frac{d\xi}{\xi} W_{n-1}(\xi) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The solution of this equation is

$$W_n(\varepsilon) = \frac{1}{\varepsilon_0} \frac{1}{(n-1)!} \left\{ ln \frac{\varepsilon_0}{\varepsilon} \right\}^{n-1}$$

as can be verified by a simple calculation. From the equation (1) the values of the mean values of ε^p after n collisions can be calculated. We have

$$\overline{\varepsilon_n^p} = -\int_0^{\varepsilon_0} \varepsilon^p \, d\varepsilon \int_\varepsilon^{\varepsilon_0} \frac{d\xi}{\xi} W_{n-1}(\xi) = \frac{1}{p+1} \int_0^{\varepsilon_0} \varepsilon^p \, W_{n-1}(\varepsilon) \, d\varepsilon = \frac{1}{p+1} \overline{\varepsilon_{n-1}^p}.$$

Taking into account the value found for $\overline{\varepsilon_1^p}$, we get

$$\overline{\varepsilon_n^p} = \left(\frac{1}{p+1} \right)^n \varepsilon_0^p.$$

Now for the discussion of the experiments it is of importance to deduce the probability $P(\varepsilon)\, d\varepsilon$ for the energy between ε and $\varepsilon + d\varepsilon$ in the case that the mean number of collisions of a group of neutrons is given.

The probability for n collisions is then given by the POISSON formula

$$p(n) = \frac{\nu^n e^{-\nu}}{n!}.$$

The probability $P(\varepsilon)\, d\varepsilon$ amounts to

$$P(\varepsilon)\, d\varepsilon = d\varepsilon \sum_0^\infty p(n) \, W_n(\varepsilon)$$

or

$$P(\varepsilon) = \sum_0^\infty \frac{\nu^n e^{-\nu}}{n!} W_n(\varepsilon) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

The probability $P(\varepsilon_0)$ is given by $e^{-\nu}$.

Introducing the value of $W_n(\varepsilon)$ into (2) we find

$$P(\varepsilon) = \frac{1}{\varepsilon_0} \sum_0^\infty \frac{\nu^n e^{-\nu}}{(n-1)!\, n!} \left(ln \frac{\varepsilon_0}{\varepsilon} \right)^{n-1}$$

which can be expressed with the help of the BESSEL function J_1. If we put

$$\nu \, ln \frac{\varepsilon_0}{\varepsilon} = \frac{x^2}{4},$$

we get for $P(\varepsilon)$

$$P(\varepsilon) = \frac{\nu e^{-\nu}}{\varepsilon_0} \frac{2}{ix} J_1(ix) \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where i is the imaginary unity. The function $P(\varepsilon)$, therefore, can be calculated with the help of tables for BESSEL functions.

From the equation (2) we can deduce the values for the mean values of ε; we get:

$$\overline{\varepsilon^p} = \int_0^{\varepsilon_0} \varepsilon^p P(\varepsilon)\, d\varepsilon = \sum_0^\infty \frac{\nu^n e^{-\nu}}{n!} \int_0^{\varepsilon_0} \varepsilon_n^p W_n(\varepsilon)\, d\varepsilon$$

$$= \sum_0^\infty \frac{\nu^n e^{-\nu}}{n!} \overline{\varepsilon_n^p} = \sum_0^\infty \frac{\nu^n e^{-\nu}}{n!} \frac{\varepsilon_0^p}{(p+1)^n} = \varepsilon_0^p e^{-\nu\left(1-\frac{1}{p+1}\right)}.$$

An equation determining $P(\varepsilon)$ can be found by the differentiation of (2). We get:

$$\frac{\delta P}{\delta \nu} = -\sum_0^\infty \frac{\nu^n e^{-\nu} W_n(\varepsilon)}{n!} + \sum_1^\infty \frac{\nu^{n-1} e^{-\nu}}{(n-1)!} W_n(\varepsilon).$$

Using (1) we get:

$$\frac{\delta P}{\delta \nu} + P = \int_\varepsilon^{\varepsilon_0} \frac{d\xi}{\xi} \sum_1^\infty \frac{\nu^{n-1} e^{-\nu}}{(n-1)!} W_{n-1}(\xi) = \frac{\delta P}{\delta \nu} + P = \int_\varepsilon^{\varepsilon_0} \frac{d\xi}{\xi} P(\xi)$$

of which (3) is a solution.

The frequency law for the case of collision with heavy nuclei can be treated in the same way. The formula for ε_1 has to be changed into

$$\varepsilon_1 = \varepsilon_0 \left(1 - \frac{4Mm}{(M+m)^2} \cos^2 \vartheta\right)$$

where M is the mass of the nucleus and m of the proton. The probability of ϑ is given by the formula

$$2 \sin \vartheta \cos \vartheta\, d\vartheta.$$

Introducing ε instead of ϑ, we find for the probability of an energy after one collision the same formula as for protons where only ε_0 has to be replaced by $\varepsilon_0 \frac{4Mm}{(M+m)^2}$.

The other formulae undergo the same change.

Utrecht, June 1936.

Physics. — *A temporary excess of ten percent in the cosmic radiation.* By J. CLAY, E. M. BRUINS, J. T. WIERSMA.

(Communicated at the meeting of June 27, 1936).

In the period of the last few months while our most used instruments were in operation in the coal-mine of Kerkrade we had arranged two recording instruments in Amsterdam. Both had ionisation chambers of 40 liter, filled with argon of 40 atm., shielded by 110 cm. of iron on all sides. Each of the chambers was connected with an electrometer triode. The method of recording was the same as described in a previous publication [1]), however a new experimental arrangement enabled us to take the records of both instruments simultaneously with the same micro-ammeter. The first instrument I was ready early in May and had given constant readings during about three weeks when the second was placed by its side on Mai 15. This second instrument was hardly in working order when both apparatus gave a sudden increase of several per cent. It was first thought that both instruments were at fault because the variation was so large. Therefore instrument I was tested again on May 27 and 28 and the other on May 28, but no fault could be found. The records of the ionisation chambers I and II are shown in fig. 1, curves I and II. The measurements with apparatus I had to be interrupted on June on account of irregularities in the connection to the condensor for the compensation.

The suspicion that the effect might be real received further support when on June 6 one of us (WIERSMA) reported that his three fold counter system, with which he was measuring the absorption coefficient of the soft primaries, had gone up on May 21 by 10 % without his being able to detect a fault in the apparatus. Before May 21 the apparatus had remained fairly constant, and on June 6 it showed a tendency to come back to this original value.

The few counter observations without absorber for the period May 20 to June 9 are also shown in fig. 1 by III, where the double arrows indicate the accuracy.

At the bottom of fig. 1 the barometer record is given. We see that the barometer had changed but very little during the period in question. There is only a slight drop on May 30 which seems to correspond to an increase in the ionisation and the coincidences as might be expected.

Further it is remarkable that all of the three instruments have a decrease from 24—27 May. Also there seems to be a small decrease previous to

[1]) J. CLAY, Phys. **1**, 363 (1934).

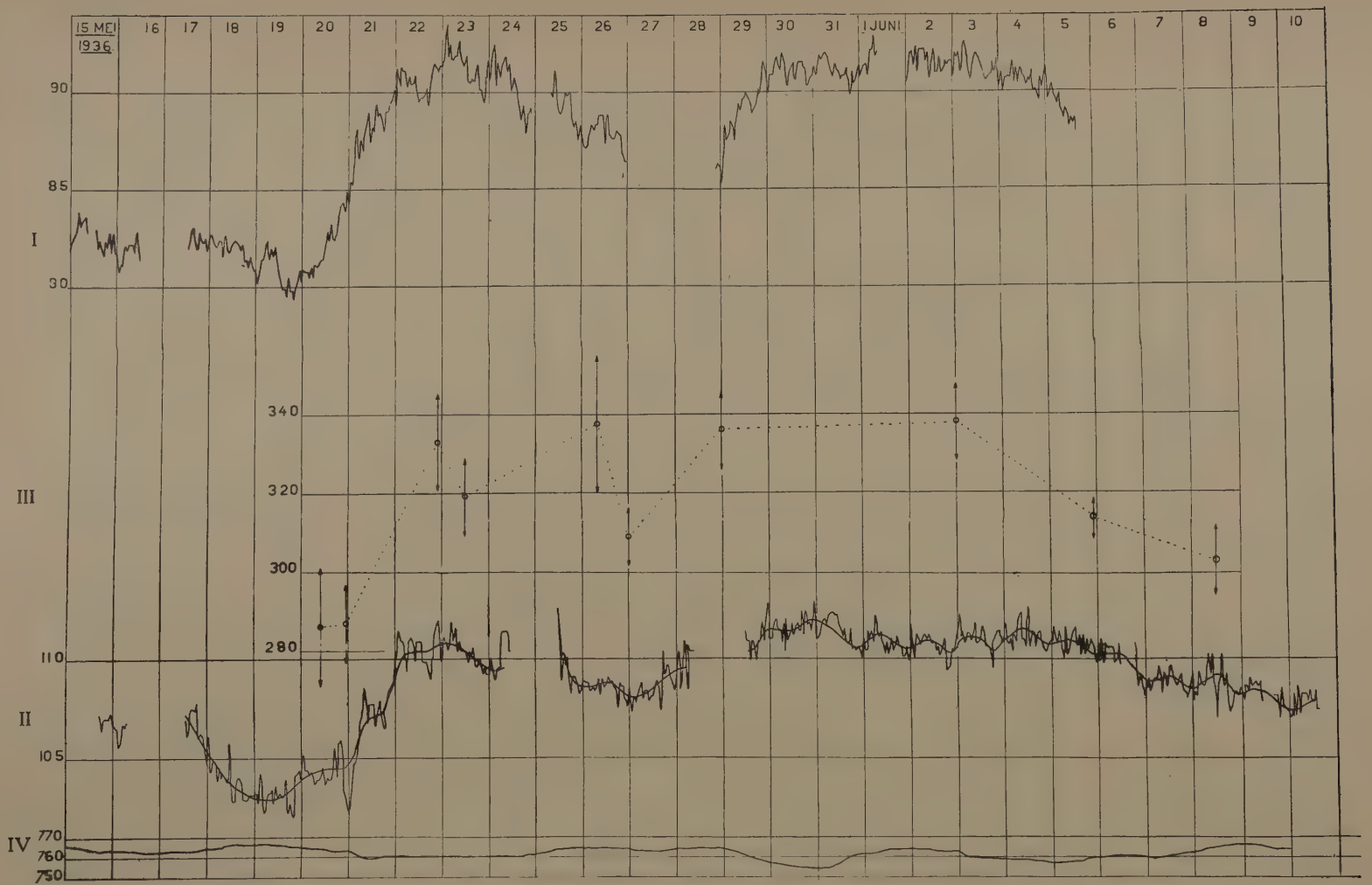

Fig. 1.

I and II. Records of the ionisation by cosmic rays.

III. Counter readings.

IV. Barometer.

May 21, which might be understood if on the days before May 18 a slight excess over the normal value had preceded the main excess, but this is only a suggestion.

It seems certain that in both the records I and II there is a small diurnal variation of about 0.8 % with a maximum at about 10^h in the morning and a minimum at 22^h. The temperature in the room was nearly constant, but moreover a temperature influence on ionisation chambers was often tried out, but never found to be present. This influence is possible on the counters, since there were large temperature variations during these days. The accuracy of the individual readings for the ionisation measurements is 0.1 %, and the accidental variations are observable in the graph. In the mean they are 0.5 %.

We think it possible that the radiation has its origin in a fixed point of the heavens, but then it is necessary that this origin is not far from the pole, because the diurnal variation is small. It may be that we are presented with an effect of the electron part of the radiation of a super-nova according to the hypothesis BAADE and ZWICKY [2]).

The effect of eventual proton radiation from a super nova recently discussed by H. ZANSTRA [3]) would not make itself felt at the earth's surface, unless the super-nova is one in our own galacy. This possibility must be excluded, since such a super-nova should have been extremely bright and certainly would have been found by the astronomers. Moreover the observed increase of cosmic ray intensity is much too sudden to be ascribable to protons, which should show a considerable time lag as compared with the light-rays and electrons.

The effect must await confirmation by other observers before it can be considered established with certainty.

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[2]) W. BAADE and F. ZWICKY, Proc. nat. Acad. Si **20**, 254 (1934).

[3]) H. ZANSTRA, Physica **3**, July 1936.

Note by the correction. The values of the recording ionisation chamber and of the counters have come back to those on 19 Mai, so that we have no reason till yet to doubt the reality of the variation. The daily variation of 0.8 % is disappeared.

Chemistry. — *Electrophoresis of Amino Compounds.* By H. R. KRUYT and G. E. VAN GILS.

(Communicated at the meeting of June 27, 1936).

During an investigation on the function of the NH_2-group particularly with a view to the electrokinetic behaviour of proteins, KRUYT and WENT[1]) performed electrophoresis measurements on a number of suspensions of amines.

In these measurements, where a flat cuvette constructed by the authors was used, the electro-endosmotic flow of liquid in the cuvette was not taken into account. The velocities of the particles were, namely, measured at half the height of the cuvette and not at the place where the liquid stands still.

For our new measurements we made use of a tubular cuvette, as was already described by one of us[2]), and the electro-endosmotic flow of liquid was taken into consideration.

The organic preparations used were once more purified by recrystallization or by sublimation (anthracene). Aniline could not be obtained sufficiently pure by vacuum distillation only. For this reason acetanilide was prepared first and, after recrystallization from water, out of this aniline was formed, which finally was distilled in vacuum. Thus a colourless product was obtained which could be preserved for months, when kept in the dark.

The suspensions were prepared in the same way as was described by KRUYT and WENT. Aniline could simply be shaken with water, diphenylamine as well, but above its melting-point, the liquid subsequently being rapidly cooled, β naphtylamine by cooling of a hot saturated solution. All other sols were obtained by dissolving the organic substance in alcohol and afterwards pouring into water (Alcohol concentration maximally 1 %). Consequently we shall have to pay regard to the influence which in these cases the alcohol with its very active OH-group may exert on the electrophoretic behaviour of the micells.

The sols were on the whole but slightly stable and the less so according as the substances were purer. Mostly „sols" could not really be spoken of. They were suspensions, the particles of which became coarser after a shorter or longer time and subsequently separated above or below in the liquid. For each measurement, therefore, we had to make new suspensions,

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[1]) H. R. KRUYT and J. J. WENT, Proc. Royal Acad. Amsterdam, **34**, 1007 (1931).
[2]) G. E. VAN GILS, Doctor Thesis, Utrecht 1936.

which then had to be measured as quickly as possible. The reproducibility of the measurements sometimes was very bad, so that only after a large number of measurements a conclusion could be drawn concerning the mean electrophoretic velocity. The measurements on suspensions of diphenylamine and β amino naphtalene in pure water showed a strong progress. For diphenylamine in water we even could not record a numerical value.

Results of the measurements.

Table 1 gives the results of the measurements, all performed at 20° C and expressed in μ/sec. per volt/cm. Taking into consideration the limited accuracy, we have given the results in one decimal only. Of the 1.5 diamino naphtalene measured by KRUYT and WENT we have not been able to make suspensions suiting our purpose. On the other hand, we had at our disposal a preparation octadecylamine, which we were so fortunate to receive from the organic-chemical laboratory at Leyden.

TABLE 1.

	m. molecules HCl/L.				
	0	1	3	5	10
Anthracene	—1.7	—0.6	f. neg.	0	0
Naphtalene	—2.8	—0.6	f. neg.	f. neg.	f. neg.
Aniline	—3.0	—2.1	—1.2		—0.5
Diphenylamine	neg.	+3.8	+5.4	+3.0	+2.1
β Naphtylamine	(—1.1)	+1.5	+2.1	+1.8	+1.3
β Amino anthracene	+1.1	+2.8		+2.7	+2.6
9 Amino anthracene	+0.7	+1.5	+1.2	+1.1	
Octadecyclamine	+4.6	+5.5	+5.4	+4.9	+4.9

Discussion of the results.

On the whole, therefore, the conclusion of KRUYT and WENT is confirmed, that the NH_2-group is the carrier of a positive charge. Whereas the hydrocarbons naphtalene and anthracene by addition of HCl lose their original negative potential but cannot be reversed in charge, the substances containing an NH_2-group may become positive (Diphenylamine and β naphtylamine).

However, now we find that the NH_2-group is so strongly positive that many amines even in *pure water* already have a positive electrophoretic velocity. This is particularly the case with the aliphatic octadecylamine.

On further addition of HCl the positive amines become still more strongly positive, and subsequently decrease in potential at a higher concentration of the acid.

All this becomes comprehensible, if we attribute two functions to the hydrochloric acid:

1. the acid will promote the dissociation of the NH_2-groups turned to the water and consequently cause the positive charge and with it also the electrokinetic potential of the micells to increase.
2. the added ions will compress the electric double-layer and consequently bring about a decrease of the electrokinetic potential.

Aniline shows a seemingly deviating behaviour, since it cannot be positively charged. However, this may be easily understood, if it is borne in mind that aniline as well as aniline chloride fairly readily dissolve in water, so that a strongly buffering solution is formed. Addition of HCl will, therefore, exert but little influence on the pH of the surroundings, and after all it is the pH which determines the dissociation of the NH_2-groups.

Diphenylamine, on the other hand, dissolves very badly in water, so that addition of small amounts of HCl already greatly alters the pH of the surroundings.

In support of what was remarked above, we performed pH measurements (with the glass electrode) of suspensions in pure water and in a 1 m.mol HCl solution (Table 2).

TABLE 2.

	pH of the suspension	
	in water	in 1 m. mol HCl
Without any addition	(c. 6.0)	3.0
Aniline	8.1	7.1
Diphenylamine	5.6	2.8
β Naphtylamine	6.2	4.3
β Amino anthracene	5.6	2.9
9 Amino anthracene	6.0	3.1

The water used was twice distilled and „free of CO_2", but nevertheless had a pH of about 6.0. A solution of 1 m. mol HCl has a pH = 3. In table 2 it is seen that the three last mentioned substances hardly change the pH of the surroundings, whereas aniline does it very strongly indeed. Never will such a pH be attained with aniline as to give rise to a positive charge of the particles.

It is a well-known fact that the hydrocarbons are negatively charged (Flow potential measurements on paraffin capillaries [1])).

The stronger basic character of the aliphatic amines, in comparison to

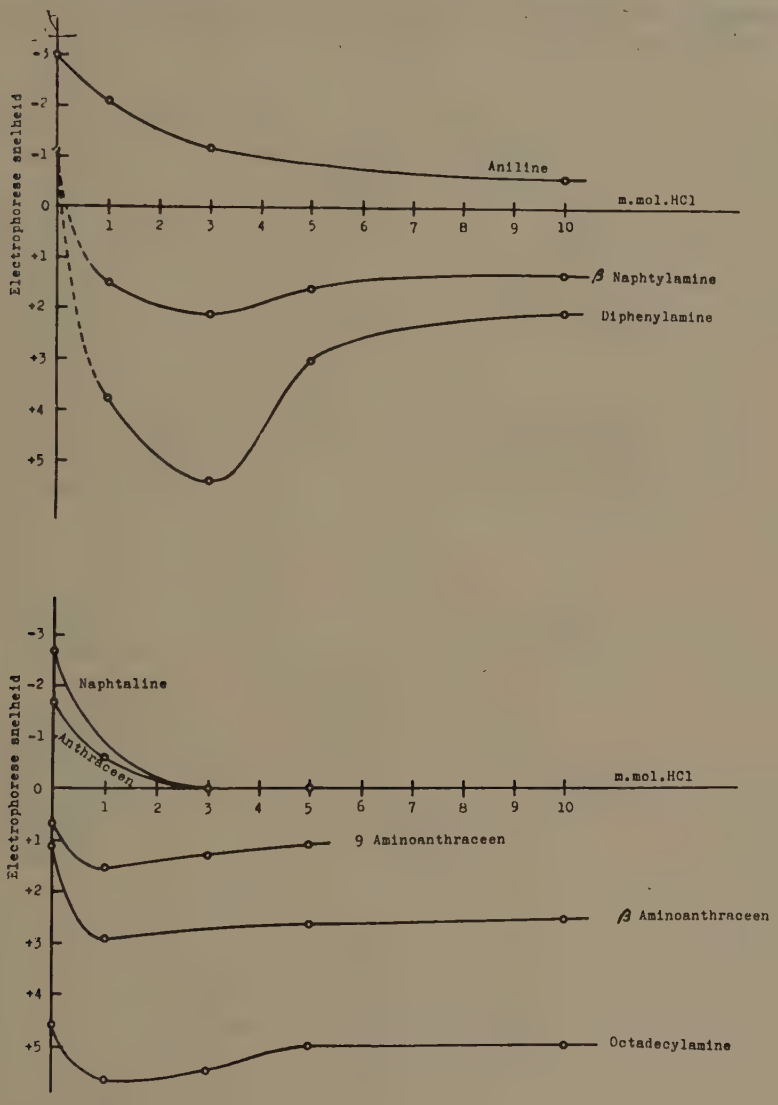

Fig. 1.

the aromatic amines, is also manifest in their electrophoretic behaviour. On determination of the degrees of dissociation of the various amines, undoubtedly a closer correlation would be found between these magnitudes and the electrophoretic behaviour.

June 1936.

Utrecht, van 't Hoff Laboratory.

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[1]) H. R. KRUYT and R. RUYSSEN, Proc. Royal Acad. Amsterdam, **37**, 498 (1934).

Psychology. — *Physical Resemblance in connection with mental similarity.* II. By E. D. WIERSMA.

(Communicated at the meeting of May 23, 1936).

Basis for the connection between physical resemblance and mental similarity.

The above investigation shows that the physical resemblance of parents and children is accompanied by a considerably greater similarity of all mental functions. Thus the previously demonstrated connection of physical and mental qualities is corroborated. Concerning the physiological phenomena this investigation does not yield information, owing to the absence of questions on this subject in the inquiry, so that for this purpose I must refer to the article [1]) cited above. One question, however, must be considered of importance in this respect. The informations obtained by it enable us to determine whether the person under discussion is mobile and agitated or calm and quiet, whether he belongs to the rapid or slow, to the quiet or restless tempo-type. It appears that with parents and children who physically resemble each other the similarity in tempo-type is considerably greater (57.8 %) than with parents and children who physically do not resemble each other (50.3 %).

Has then, in case of physical resemblance of parents and children, the similarity in all mental qualities increased in about the same measure? This is not likely, for it is to be expected that, as is the case physically, also mentally a greater or smaller similarity will be found. Concerning the measure of physical resemblance the heredity-inquiry does not give further information. The reporters probably founded their judgment on the general impression obtained by them on seeing the persons. It would, of course, be of great importance to institute a more detailed inquiry, but for the present we have to be satisfied with the data that have been given.

There are yet other circumstances asking for attention. The heredity of physical phenomena is well known and also for mental qualities it has been ascertained [2]). However, it is exceedingly difficult, and this has been pointed out emphatically in the article cited above, to distinguish the influence of heredity from that of education. On comparison of the heredity coefficients for qualities influenced by education, such as activity, compassion, patriotism, political persuasion and religiousness, with the heredity coefficients for qualities which are not or hardly influenced by education, e.g. emotionality, consolability, intelligence, memory, it appears

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1) Verhandelingen der Koninklijke Akademie. Deel XXX, N°. 2 (1933).

2) Beiträge zur speziellen Psychologie auf Grund einer Massenuntersuchung von G. HEYMANS u. E. D. WIERSMA. Zeitschr. f. Psychologie, Bd. 45 (1907).

that the influence of heredity on character formation by far exceeds that of education [1]). Does the above investigation point in the same direction? The physical resemblance of children to their parents is due to heredity. No influence of education or of intercourse can have played a part here. Since the mental qualities of children and parents show a greater similarity if they physically resemble each other than when they do not resemble each other, it can hardly be assumed here either that education and intercourse may have had a very large influence. It is obvious that the greater mental similarity should be ascribed, at any rate in the main, to heredity. How great now is the similarity of the above-mentioned mental qualities, the first group of which is greatly, the second only slightly influenced by education and intercourse, of the children to their parents whom they resemble and to the parents whom they do *not* resemble? The following tables give a synopsis of this.

Percentage of children with similarly directed qualities as the parents whom they physically resemble or do *not* resemble.

Qualities influenced by education and intercourse:	*Resemble*	*Do not resemble*	*Difference*
Activity	63.4	58.7	4.7
Compassion	63.7	60.0	3.7
Patriotism	35.9	29.7	6.2
Political persuasion	26.9	21.2	5.7
Religiousness	45.2	40.2	5.0
Average	47.0	41.9	5.1
Qualities not influenced by education and intercourse:			
Emotionality	48.8	40.2	8.6
Consolability	33.6	27.3	6.3
Intelligence	32.8	31.6	1.2
Memory	65.0	62.7	2.3
Average	45.1	40.5	4.6

From these tables it appears that the average differences in similarity of the qualities either influenced or not by education and intercourse between the children with their parents whom they resemble and the children with their parents whom they do *not* resemble hardly deviate from each other. In the first as well as in the second group of qualities the differences have to be chiefly ascribed to heredity and only for a small part to education and intercourse.

Organization of the psychical phenomena.

The question which psychical phenomena are more and which less hereditary has been discussed in the article cited above [2]). DE CANDOLLE

1) Zeitschr. f. Psychologie, Bd. **45**.

2) Beiträge zur speziellen Psychologie auf Grund einer Massenuntersuchung. Zeitschr. f. Psychologie, Bd. **45** (1907).

and RIBOT on the ground of experience and theoretical considerations suggested that the heredity of moral qualities is greater than that of intellectual ones. This suggestion is corroborated by the results of the heredity-inquiry. This result is plausible because the intellectual qualities are younger and less organized, the moral ones older and better organized.

The above investigation can also contribute to the solution of the question which phenomena are most highly organized. The best organized phenomena are most closely connected with physical functions and will display a greater similarity, if parents and children resemble each other physically, than when this physical resemblance does not exist. From the above tables it appears that the difference in similarity between parents and children who resemble each other and those who do *not*, with respect to the simple temperamental qualities, amounts to 7.6 %, the compound temperamental qualities 9.5 %, the types of temperament 6.6 %, so averagely 7.9 %, with regard to the vital tendencies 4.5 %, the egophilic and altruistic tendencies 6.2 %, the abstract ones 5.6 %, so averagely 5.4 %, with regard to the intellectual qualities 4.8 %. These results confirm the earlier suggestions that the intellectual qualities are the least organized, the least deep-rooted psychical qualities, the temperamental qualities the best organized, the deepest-rooted ones, and that between these two the moral qualities have to be placed.

Physics. — *Ueber die Lage des λ-Punktes beim Helium.* Von J. J. VAN LAAR.

(Communicated at the meeting of June 27, 1936).

I

Herr Prof. KEESOM war so freundlich mir darauf aufmerksam zu machen, dasz die Temperatur 1°.83 ($p = 29.8$ atm.) in Comm. 184*b* (1926) nach der damals benutzten Temperaturskala (von 1926) gemessen wurde, und dasz dagegen die Temperaturen in Comm. 224*e* (1933) nach einer neuen, etwas abweichenden Skala (von 1932) bestimmt worden sind. Diese Tatsache war mir leider unbekannt geblieben, ebenso wie die Korrektionstabelle der einen auf der anderen Skala in Suppl. 71*d*, § 4, weil diese Publikation nur zitiert wurde (und zwar § 3) in Comm. 224*d* (S. 20). Diese letztere war aber von mir nicht berücksichtigt, weil der Inhalt derselben auszerhalb des Rahmens meiner jetztigen Untersuchung fiel.

Nach der genannten Tabelle ist nun 1°.83 (1926) = 1.75^5 (1932), sodasz wir jetzt folgendes haben:

λ-Punkt nach KEESOM und Frl. KEESOM (1933) $T = 1.75^3$, $p = 29.91$.
Punkt 1°.83 auf Schmelzkurve I (KEESOM 1926) $T = 1.75^5$, $p = 29.8$.

Noch immer ist also der Druck auf I, ein wenig *oberhalb* des λ-Punktes, etwas *niedriger* als im λ-Punkte selber, was natürlich unmöglich ist. Diese Tatsache ist jedoch nach KEESOM von keiner Wichtigkeit, da in Comm. 184*b* (1926), S. 15 bemerkt wurde: „The melting pressure could be fixed to some few tenths of an atmosphere", sodasz der damals gemessene Druck 29.8 dennoch wohl etwas höher als 29.9 sein kann. Die von K. und Frl. K. gefundenen Werte für T und p im λ-Punkte können somit aufrecht bleiben, wodurch die Abänderung in § 1, S. 613 meines letzten Aufsatzes (Proceed. **39**, N°. 5, 612—622) hinfällig wird.

II

In der Einleitung (S. 612) schrieb ich über die von KEESOM „berechneten" Schmelzwärmen, weil im betreffenden sehr kurzen Aufsatz von K. und Frl. K. in Proceed. **39**, N°. 1, S. 9 steht: „For the melting heat the following values were „derived". Der ausführliche Aufsatz in *Physica* III, S. 105—117 wurde mir erst vor einigen Tagen von Heinn KEESOM gütigst zugesandt, woraus sich ergibt, dasz die betreffenden Schmelzwärmen nicht „berechnet", sondern experimentell bestimmt worden sind.

Es bedarf wohl nicht erwähnt zu werden, dasz die kleine Verbesserung hinsichtlich der Lage des λ-Punktes in keinerlei Weise den Inhalt meines Aufsatzes beëinfluszt, da derselbe sich auf Beobachtungen auf den beiden Schmelzkurven, links und rechts des λ-Punktes, bezieht.

Tavel sur Clarens (Schweiz), Juni 1936.

Botany. — *On some Malayan Ferns.* By O. POSTHUMUS, (Pasoeroean) Java.

(Communicated at the meeting of June 27, 1936).

The following note is the result of a study of the type specimens of some less known Malayan Ferns. I wish to express my sincere thanks to the Directors of the Herbarium of the Botanical Gardens, Buitenzorg, and of the State Herbarium, Leyden, who kindly allowed me to study the material. From the Leyden Herbarium I also received photographs of some type specimens from BLUME.

Dryopteris menisciicarpa (BLUME) ROSENSTOCK.

After examining the specimen of *Dryopteris cordifolia* V.A.v.R. [1]) from Labang, N. Borneo (VAN GENDEREN STORT 522), also the other specimens mentioned from Boekit Aloe Seboekoe (VAN GENDEREN STORT 449 p.p. and 524), and from Sedali (VAN GENDEREN STORT 298) in the Buitenzorg Herbarium, I cannot distinguish this fern from **Dr. menisciicarpa** ROS. [2]).

C. CHRISTENSEN identifies *Dr. cordifolia* V.A.v.R. with *Dr. mirabilis* COPELAND [3]); the latter species has also been identified [4]) with *Dr. holophylla* (BAKER) C. CHR. which represents juvenile specimens with undivided fronds. Both are present in the type material of *Dr. cordifolia* V.A.v.R.; mature fronds with well developed pinnae, with their characteristic truncate base, which are reduced to basal lobes in nearly entire leaves, as is shown in the figures. This species, also including *Dr. verreculosa* V.A.v.R. [5]), consequently has now been found to occur in the Malay Peninsula, Sumatra, Borneo, West and East Java; in the latter region except from the type locality of *Dr. verreculosa* V.A.v.R. at the S. coast, S. of Malang, it has also been found near Kalibaroe, at the S. slope of Mt. Raoeng and on the E. slope of Mt. Merapi above Banjoewangi, at 900 M altitude. The specimens, mentioned in my former paper [2]), CLEMENS 26923 and CLEMENS 27430, which I thought to be the same, I now consider to be really different, though closely allied to **Dr. menisciicarpa** ROS.

Lindsaya javanensis BLUME [6]).

Of this fern, which is commonly considered to be identical with **Lindsaya orbiculata** [7]) METTENIUS, the type specimen in the Leyden Herbarium proved to be characterized by rhomboid, more or less acuminate pinnules, with flabellate venation.

In this respect it quite agrees with the variety gigantea of *L. flabellulata* as described by HOOKER [8]), which has been distinguished also as a variety of *L. tenera* DR. and more recently as separate species, *L. gigantea* (HK.) C. CHR. [9]). If this species be recognized as a distinct one, the old name **Lindsaya javanensis** BLUME, should be used again.

Lindsaya lucida BLUME [10]).

This species, created by BLUME in 1828, was afterwards considered as a variety of **Lindsaya gracilis** BL. only [11]). The specimen in the Leyden herbarium, however, appeared to be clearly distinct in many respects from the latter species, the most important difference being that the rhizome is not longcreeping. In the same way *Lindsaya crenulata* FÉE [12]) and *L. Lobbiana* HOOKER [13]) were considered to be identical with **L. gracilis** BLUME [14]). HOLTTUM was the first to show that *L. Lobbiana* HK. was different from **L. gracilis** BLUME [15]), and identical with *L. propria* V.A.v.R. He argued the possibility of *L. crenulata* FÉE being the same; C. CHRISTENSEN agrees with this standpoint [16]). Examination of the type specimen of **L. lucida** BL. in the Leyden Herbarium convinced me that **L. lucida** BL. is identical with *L. Lobbiana* HK. and *L. propria* V.A.v.R. It is distinguished from **L. gracilis** BL. by its rhizome being shorter, the leaflets bigger; from **L. cultrata** SW., by its lower leaflets being smaller and curved downwards. I do not believe *L. crenulata* FÉE to be identical with **L. lucida** BL.; in the shape of its pirmae it is more like **L. cultrata** SW.

Polypodium trilobum HOUTTUYN [17]).

This name has been given by HOUTTUYN to a fern from Java, collected by THUNBERG on the mountains S. of Batavia. The plate shows a trilobed leaf of characteristic appearance, the lateral lobes of which are placed nearly perpendicular to the petiole, and are rather pointed from a broad base. This is characteristic of the Java Ferns in *Polypodium incurvatum* BLUME only [18]); I have no doubt that the two plants are identical.

C. CHRISTENSEN [19]) refers *Polypodium triphyllum* JACQUIN [20]) to the same species; this name, however, dates from 1788 and that of HOUTTUYN from 1783; the latter, therefore, is the older and should be used.

Pteris umbraculifera METTENIUS.

This fern, described by METTENIUS [21]) on a specimen collected by VAN BEUSEKOM on Mt. Pangerango, has been united by HOOKER—BAKER [22]), CHRISTENSEN and other authors, e.g. VAN ALDERWERELT VAN ROSENBURGH, with **Pt. longipinnula** WALL. The examination of the type specimen in the Leyden Herbarium, however, shows that this fern is different.

Its most prominent feature is the arrangement of the pinnae; in the type specimen on the top of the petiole 4 pinnae are inserted, and the scar of a fifth pinna, probably the same which is pasted separately on the sheet, can be seen. Between the insertion of the pinnae 3 small pinnules, resembling the smaller lowermost pinnules of the pinnae, are inserted. In this feature it differs from **Pt. pellucens** AG. [23]), the leaf of which is tripartite, or, if sometimes 5-partite, the lower pinnae being branched, the leaf is pedate, without basal pinnules.

The same structure of the leaf is said to occur in *Pteris radicans* CHRIST [24]), though the basal pinnules are not indicated in his description. In 1930 I visited the forest at the SW. slope of the Peak of Mt. Bonthain in S. Celebes, where the type material of *Pt. radicans* had been collected, and found this fern to be rather frequent in many places at about 1200—2000 M. altitude. It seems to me quite identical with **Pt. umbraculifera** METTENIUS. At present this species is known to occur in W. Java: Mt. Pangerango, (type locality); East Java; Mt. Dorowati, ca 1500 M., POSTHUMUS 1823, 12-5-1929 (HB, P, POJ); Bali: Bratan caldera, near Bedoegoel, ca 1300 M., POSTHUMUS 3692, 22-11-1933 (P, HB); Flores: Rana mese, POSTHUMUS 3290, 14-11-1932 (P, HB), and SW. Celebes: Mt. Bonthain, SW. slope above Karoenglowe, ca 1500 M., POSTHUMUS 2717, 20-11-1930 (P, POJ).

Thysanobotrya dubia (v. A. VAN ROSENBURGH) nov. comb.

Stenochlaena dubia VAN ALDERWERELT VAN ROSENBURGH, Bulletin Dept. Agric. Indes Néerl., XVIII, p. 26, (1908); Malayan Ferns, p. 721 (1909).

Polybotrya arfakensis GEPP in GIBBS, Contribution to the Phytogeography and Flora of the Arfak Mountains, p. 71 (1917).

Thysanobotrya arfakensis VAN ALDERWERELT VAN ROSENBURGH, Bulletin Jardin Bot. de Buitenzorg, (II) vol. **28**, p. 66 (1918).
Cyathea Gibbsiae COPELAND, Phil. Journ. of Science, vol. **38**, p. 129 (1929).
Alsophila biformis ROSENSTOCK, Fedde's Repertorium, vol. **9**, p. 423 (1911).
Alsophila biformis BRAUSE, Hedwigia, vol. **61**, p. 401 (1920).
Alsophila biformis BRAUSE, Engler's Bot. Jahrbücher, Bd **56**, p. 74 (1920).
Alsophila biformis POSTHUMUS in RANT, Reizen naar Ambon, Natuurk. Tijdschr. voor N. I., vol. **94**, p. 119 (1934).
Cyathea biformis COPELAND, Phil. Journ. of Sci. Bot., vol. **6**, p. 364 (1911).

This is the rather complicated synonymy of the first described species of a well characterized group of Cyatheaceae with thin, scandent stems and dimorphous leaves. The habit of sterile specimens explains it having been included in both the genera *Polybotrya* and *Stenochlaena*.

When I saw the sterile type specimen of *Stenochlaena dubia* V.A.v.R. for the first time in 1931, I already suspected it to belong to *Alsophila biformis* ROSENSTOCK, of which I had before seen good material of New Guinea, collected by DOCTERS VAN LEEUWEN: Rouffaer river, ca 175 M., no. 9821, and no. 10399 (now in the Buitenzorg Herbarium).

Its identity was confirmed afterwards by the beautiful specimens, now in the Buitenzorg herbarium, collected by RANT on Amboyna on the summit of Mt. Salhoetoe, ca 1000 M. (no. 745), the same locality where TEYSMANN collected the specimens described by VAN ALDERWERELT VAN ROSENBURGH as *Stenochlaena dubia*. Similarly to the material, collected by TEYSMANN, the fructifications clearly showed its true nature.

This characteristic species seems to have developed from a group of species in *Alsophila*, which are characterized by dark coloured rachises and by often much contracted fertile pinnules. To this group belong e.g. **Alsophila commutata** METT. (Malay Peninsula, Borneo) and **A. dimorpha** CHRIST. (Celebes). Of New Guinea species belong to this group **A. Ledermannii** BRAUSE, **A. olivacea** BRAUSE, and **A. brunnea** BRAUSE. In this group, however, some species are characterized further by thin stems, ca 1—2 cM thick, scandent, often somewhat flattened on one side as the rhizomes of **Stenochlaena**, from which they can easily be distinguished by the scales.

Though both BRAUSE and COPELAND include *Thysanobotrya* in **Alsophila**, resp. **Cyathea**, because of the structure of the sori being the same as in the above-mentioned forms, it seems to me that the combination of scandent stems and dimorphous pinnules, which has already been mentioned by VAN ALDERWERELT in his diagnosis, fully justifies the separation of the genus **Thysanobotrya** from the rest of the complex group, now known either as **Cyathea** only (COPELAND, HOLTTUM) or as **Alsophila, Hemitelia** and **Cyathea** (C. CHRISTENSEN in his Index Filicum).

The genus **Thysanobotrya** includes two species: 1. **Thysanobotrya dubia**

(V.A.v.R.) nov. comb., mentioned above. COPELAND doubts the identity of *Thysanobotrya arfakensis* (V.A.v.R.) with *Alsophila biformis* ROSENSTOCK, but both BRAUSE and CHRISTENSEN consider both species to be identical. 2. **Thysanobotrya scandens** (BRAUSE) nov. comb. (*Alsophila scandens* BRAUSE, Engler's Bot. Jahrbücher, vol. **59**, p. 77 (1920)).

The position of **Alsophila Rosenstockii** BRAUSE (l.c., p. 64) is not quite certain; it may belong to the same genus.

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3. Phil. Journal of Science, vol. **6**, c, p. 137, pl. 19 (1911).
4. Gardens Bulletin, VII, p. 249 (1934); Index Filicum, third supplement, p. 91 (1934).
5. l.c., p. 94.
6. BLUME, Enumeratio, p. 219 (1828).
7. C. CHRISTENSEN, Index Filicum, p. 394 (1906).
8. HOOKER, Species Filicum, p. 211, pl. LXIII C (1846).
9. C. CHRISTENSEN in Engler Bot. Jahrbücher, vol. **66**, p. 53 (1933).
10. BLUME, Enumeratio, p. 216 (1828).
11. C. CHRISTENSEN, Index Filicum, p. 395 (1906).
12. FÉE, Genera Filicum, p. 105, pl. 28, fig. 2 (1850—'52).
13. HOOKER, Species Filicum, I, p. 205, pl. 62 C (1846).
14. C. CHRISTENSEN, Index Filicum, p. 392, 395 (1906).
15. HOLTTUM, Gardens Bulletin, Singapore, vol. **5**, p. 61 (1930).
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18. BLUME, Enumeratio, p. 126 (1828); Flora Javae, Filices, p. 151, pl. 65 (1828).
19. C. CHRISTENSEN, Index Filicum, third Supplement, p. 161 (1934).
20. JACQUIN, Collectanea, vol. **2**, p. 284, pl. 22, fig. 1 (1788).
21. METTENIUS, Ann. Mus. Bot., Lugd. Bat., IV, p. 97 (1868—1869).
22. HOOKER—BAKER, Synopsis Filicum, second ed., p. 158 (1874).
23. Pt. Zollingeriana Mettenius is the same; it is sometimes mentioned as Pteris longipes Don, which, however, according to the description in Agardh, Recensio, seems to be a Lithobrochia.
24. CHRIST, Verh. naturf. Ges. Basel, XI, p. 431 (1896); Ann. du Jardin Bot. de Buitenzorg, XV, p. 110 (1897).
25. HB = Herbarium, Buitenzorg, POJ = herbarium of the Sugar Experiment Station, Pasoeroean; P = my own herbarium.

Mathematics. — *Ortsoperatoren in konkreten Hilbertschen Räumen.* I. By HANS FREUDENTHAL. (Communicated by Prof. L. E. J. BROUWER.)

(Communicated at the meeting of June 27, 1936).

Differentialoperatoren unterscheiden sich von andern konkreten Operatoren, etwa den Integraloperatoren, Differenzenoperatoren, Substitutionsoperatoren, durch sehr allgemeine Züge; diese Züge wollen wir erfassen, indem wir den Begriff des Differentialoperators zu dem des Ortsoperators verallgemeinern.

1. (1 . 1) $\mathfrak{R}$ sei im Folgenden stets ein vollständiger unitärer Raum (Hilbertscher Raum ohne Dimensions- und Mächtigkeitsaxiome); seine Elemente werden mit x, y, z, seine linearen Teilräume mit groszen gotischen Buchstaben bezeichnet, lineare Operatoren in ihm mit groszen lateinischen Buchstaben. $\mathfrak{D}(A)$ bedeute die Definitionsmenge von A. A^* ist der zu A adjungierte Operator. Die Zeichen $\curlyvee$, $\bigvee$ bzw. $\curlywedge$, $\bigwedge$ deuten die Vereinigungs- bzw. Durchschnittsbildung an.

(1 . 2) Ist $\mathfrak{S}$ abgeschlossen und $A(\mathfrak{S} \curlywedge \mathfrak{D}(A)) \subset \mathfrak{S}$ (d.h. $Ax \in \mathfrak{S}$ für jedes $x \in \mathfrak{S}$, für das A definiert ist), so verstehen wir unter $A \curlywedge \mathfrak{S}$ den in $\mathfrak{S} \curlywedge \mathfrak{D}(A)$ definierten und dort mit A übereinstimmenden Operator, aufgefaszt als Operator in dem unitären Raum $\mathfrak{S}$.

(1 . 3) **Satz:** A sei ein in $\mathfrak{R}$ überall dicht definierter linearer Operator. $\mathfrak{R}_n$ sei eine aufsteigende Folge abgeschlossener linearer Teilräume von $\mathfrak{R}$, deren Vereinigung in $\mathfrak{R}$ überall dicht liege; P_n sei die Projektion auf $\mathfrak{R}_n$. $\mathfrak{D}_n = \mathfrak{R}_n \curlywedge \mathfrak{D}(A)$ sei überall dicht in $\mathfrak{R}_n$, und es sei $A\mathfrak{D}_n \subset \mathfrak{R}_n$. Wir setzen $A_n = A \curlywedge \mathfrak{R}_n$ (also $\mathfrak{D}(A_n) = \mathfrak{D}_n$). Dann ist $P_n \mathfrak{D}(A^*) \subset \mathfrak{D}(A_n^*)$ für alle n und $A^* y = \lim A_n^* P_n y$.

Bemerkung: Dieser Satz liefert eine Abschätzung nach oben für $\mathfrak{D}(A^*)$.

Beweis: Sei $y \in \mathfrak{D}(A^*)$, also (Ax, y) beschränkt in $x \in \mathfrak{D}(A)$, $|x| \leqq 1$, also auch beschränkt in $x \in \mathfrak{D}(A_n)$, $|x| \leqq 1$. Nun ist aber $(Ax, y) = (A_n x, P_n y)$ für $x \in \mathfrak{D}(A_n)$, also $P_n y \in \mathfrak{D}(A_n^*)$ (womit ein Teil des Satzes bewiesen ist). Man darf also in der Gleichung A bzw. A_n in das rechte Glied des inneren Produktes bringen: $(x, A^* y) = (x, A_n^* P_n y)$ für $x \in \mathfrak{D}(A_n)$, also überhaupt für $x \in \mathfrak{R}_n$. Oder: $P_n (A_n^* P_n - P_n A^*)' y = 0$. Also: $A_n^* P_n y = P_n A^* y$, woraus der Rest des Satzes unmittelbar folgt.

2. (2 . 1) $\mathfrak{e}$ sei ein topologischer Raum; $\mathfrak{e}$ sei mit einem Lebesgue-Fréchetschen Masz versehen (das für gewisse Teilmengen unendlich werden darf); jede offene Menge sei meszbar, $\mathfrak{m}$ sei stets eine meszbare Teilmenge von $\mathfrak{e}$. $\mathfrak{R}_\mathfrak{m}$ sei der unitäre Raum der auszerhalb $\mathfrak{m}$ verschwindenden absolutquadratintegrablen Funktionen über $\mathfrak{e}$. $P_\mathfrak{m}$ sei die Projektion von

$\mathfrak{R}_\mathfrak{e}$ auf $\mathfrak{R}_\mathfrak{m}$ (die nichts Anderes ist als die Multiplikation mit der auszerhalb $\mathfrak{m}$ verschwindenden, in $\mathfrak{m}$ gleich 1 gesetzten Funktion). Gleichheits- und Konvergenzbegriff für Funktionen seien die des unitären Raumes.

(2.2) Der in einem Teilraum von $\mathfrak{R}_\mathfrak{e}$ definierte lineare Operator A heiszt *Ortsoperator*, wenn für jedes $\mathfrak{m}$ gilt: Jede in $\mathfrak{m}$ verschwindende Funktion von $\mathfrak{R}_\mathfrak{e} \frown \mathfrak{D}(A)$ wird durch A in eine ebensolche abgebildet; $\mathfrak{R}_\mathfrak{m} \frown \mathfrak{D}(A)$ ist überall dicht in $\mathfrak{R}_\mathfrak{m}$.

(2.3) Eine gewisse abgeschlossene, nirgendsdichte Teilmenge $\mathfrak{r}$ von $\mathfrak{e}$ sei als *Rand* von $\mathfrak{e}$ ausgezeichnet. $\mathfrak{o}$ bedeute stets eine offene Menge, die aus $\mathfrak{e}$ entstehe durch Weglassen einer abgeschlossenen Umgebung von $\mathfrak{r}$. Der Rand von $\mathfrak{o}$ ist im üblichen Sinne zu verstehen.

(2.4) Bei den Anwendungen wird $\mathfrak{e}$ im Allgemeinen kompakt sein, und zwar entstanden aus dem im Kleinen kompakten Definitionsbereich durch Hinzufügung idealer Punkte, die alle oder teilweise als Punkte von $\mathfrak{r}$ auftreten können. Es ist klar, wie man dann den Satz (1.3) anwenden kann, wenn A ein Lokaloperator, $\mathfrak{o}_n$ eine gewisse aufsteigende Folge (2.3) und $\mathfrak{R}_n = \mathfrak{R}_{\mathfrak{o}_n}$ ist.

(2.5) Sei A Ortsoperator, $\mathfrak{m}_1 \subset \mathfrak{m}_2 \subset \mathfrak{e}$, $A_n = A \frown \mathfrak{R}_{\mathfrak{m}_n}$, P die Projektion von $\mathfrak{R}_{\mathfrak{m}_2}$ auf $\mathfrak{R}_{\mathfrak{m}_1}$. Dann ist $P\mathfrak{D}(A_2^*) \subset \mathfrak{D}(A_1^*)$ und (soweit definiert) $PA_2^* y = A_1^* Py$. (Klar.)

(2.6) Ein Ortsoperator A heiszt hermitesch bzw. selbstadjungiert *im Innern von* $\mathfrak{e}$, wenn eine aufsteigende Folge $\mathfrak{o}_n$ existiert, $\mathfrak{r} \smile \bigvee \mathfrak{o}_n = \mathfrak{e}$, mit der Eigenschaft: Sei $A_n = A \frown \mathfrak{R}_{\mathfrak{o}_n}$, $P_n = P_{\mathfrak{o}_n}$; dann ist 1. A_n hermitesch, 2. $\mathfrak{D}(A_n^*) \supset P_n \mathfrak{D}(A_{n+1})$ bzw. $\mathfrak{D}(A_n^*) = P_n \mathfrak{D}(A_{n+1})$. — Für den Fall eines kompakten $\mathfrak{e}$ zeigt man leicht, dasz diese Definitionen von der Wahl der Folge $\mathfrak{o}_n$ nicht abhängen (was aber nicht wesentlich ist.)

(2.7) Es läge nahe, in die Definition des Ortsoperators noch folgende natürliche Forderungen aufzunehmen: Für beliebige $\mathfrak{o}$ und $\mathfrak{o}'$ mit zueinander fremder abgeschlossener Hülle und beliebige x und x' aus $\mathfrak{D}(A)$ gibt es ein x'' aus $\mathfrak{D}(A)$, das in $\mathfrak{o}$ mit x und in $\mathfrak{o}'$ mit x' übereinstimmt. Für beliebige $\mathfrak{o}$ und $\mathfrak{o}'$ mit $\bar{\mathfrak{o}} \subset \mathfrak{o}'$ und beliebige x und x' aus $\mathfrak{D}(A)$ gibt es ein x'' aus $\mathfrak{D}(A)$, das in $\mathfrak{o}$ mit x und auszerhalb $\mathfrak{o}'$ mit x' übereinstimmt. Wir werden aber von der ersten Forderung keinen Gebrauch machen; die zweite dagegen werden wir teilweise verwenden, wir werden nämlich verlangen (mit den Bezeichnungen von 2.6):

(2.8) $P_n \mathfrak{D}(A) = P_n \mathfrak{D}(A_{n+1})$.

(2.9) Wir nennen $\mathfrak{T}(A)$ die Gesamtheit der $x \in \mathfrak{R}_\mathfrak{e}$, die in jedem $\mathfrak{o}_n$ mit einem geeigneten $x_n \in \mathfrak{D}(A)$ übereinstimmen. Dann ist also (für jedes n) $P_n \mathfrak{T}(A) = P_n \mathfrak{D}(A)$ und $\mathfrak{D}(A) \subset \mathfrak{T}(A)$.

3. Satz: A sei im Innern von $\mathfrak{e}$ selbstadjungiert, und es gelte (2.8). Dann ist $\mathfrak{D}(A_n) \subset \mathfrak{D}(A^*) \subset \mathfrak{T}(A)$ und $P_n \mathfrak{D}(A) = P_n \mathfrak{D}(A^*) = P_n \mathfrak{T}(A)$, und man kann für jedes $x \in \mathfrak{D}(A^*)$ $A^* x$ einfach so berechnen, dasz

man ein (stets existierendes) $y \in \mathfrak{D}(A)$ sucht, das in einem $\mathfrak{o}_n$ mit x übereinstimmt, und $A^* x = A y$ in ganz $\mathfrak{o}_n$ setzt. $\mathfrak{D}(A^*)$ läszt sich aus $\mathfrak{T}(A)$ durch eine *Randbedingung* herausheben, ebenso jede Fortsetzung von $\mathfrak{D}(A)$, in der A maximal oder selbstadjungiert ist, aus $\mathfrak{D}(A^*)$. Einschränkung durch eine Randbedingung bedeutet dabei: Zwei Elemente des einzuschränkenden Bereichs, die auszerhalb eines geeigneten $\mathfrak{o}_n$ übereinstimmen, gehören entweder alle beide wohl oder alle beide nicht zum eingeschränkten Bereich. Oder: Jedes auszerhalb eines geeigneten $\mathfrak{o}_n$ verschwindende Element des einzuschränkenden gehört zum eingeschränkten Bereich.

Die Behauptungen des Satzes sind in denen von 3.1—8 enthalten:

(3.1) Für $x \in \mathfrak{D}(A_{n+1})$ bzw. $\in \mathfrak{D}(A)$ ist $A_n^* P_n x = P_n A_{n+1} x$ bzw. $= P_n A x$. Also es gilt nicht nur die in 2.6.2 geforderte Uebereinstimmung von Definitionsbereichen, sondern auch die der zugehörigen Operatoren.

Beweis: $x \in \mathfrak{D}(A_{n+1})$. Wegen 2.6.1 und 2.5 hat man $P_n A_{n+1} x = P_n A_{n+1}^* x = A_n^* P_n x$. Sei nun $x \in \mathfrak{D}(A)$. Wegen 2.6.2 und 2.8 ist $P_n x \in \mathfrak{D}(A_n^*)$ und existiert $z \in \mathfrak{D}(A_{n+1})$ mit $P_n x = P_n z$. Dann ist aber auch, weil A Ortsoperator ist, $P_n A x = P_n A z$; das ist aber $= P_n A_{n+1} z = A_n^* P_n z$ (auf Grund des bereits bewiesenen ersten Teils der Aussage) $= A_n^* P_n x$.

(3.2) Ist $x \in \mathfrak{D}(A)$, $y \in \mathfrak{D}(A_m^*)$ bzw. $\in \mathfrak{D}(A^*)$ und stimmen x und y in $\mathfrak{o}_n$ $(n \leqq m)$ überein, so tun das auch Ax und $A_m^* y$ bzw. $A^* y$.

Beweis: Es sei $x \in \mathfrak{D}(A)$, $y \in \mathfrak{D}(A_m^*)$, $P_n x = P_n y$. Dann gilt $P_n A x = A_n^* P_n x = A_n^* P_n y = P_n A_m^* y$, und zwar gilt das erste Gleichheitszeichen wegen 3.1, das zweite nach Voraussetzung, das dritte nach 2.5 für $m > n$ (sonst ist es trivial). — Für $y \in \mathfrak{D}(A^*)$ hat man nach 2.6.2 und 2.8 $P_n y \in \mathfrak{D}(A_n^*)$ und kann dann weiter verfahren wie im ersten Teil des Beweises.

(3.3) Ist $x \in \mathfrak{D}(A_k^*)$, $y \in \mathfrak{D}(A_l^*)$ bzw. $x \in \mathfrak{D}(A_k^*)$, $y \in \mathfrak{D}(A^*)$ bzw. $x, y \in \mathfrak{D}(A^*)$ und stimmen x und y in $\mathfrak{o}_n$ $(n \leqq k, l)$ überein, so tun das auch $A_k^* x$ und $A_l^* y$ bzw. $A_k^* x$ und $A^* y$ bzw. $A^* x$ und $A^* y$.

Beweis: Sei $x \in \mathfrak{D}(A_k)$, $y \in \mathfrak{D}(A_l)$, $P_n x = P_n y$. Nach 2.6.2 und 2.8 existiert ein $z \in \mathfrak{D}(A)$ mit $P_n x = P_n y = P_n z$. Nach 3.2 stimmen $A_k^* x$ und $A_l^* y$ mit Az in $\mathfrak{o}_n$ überein, also auch untereinander. — Ebenso ergibt sich der Rest.

(3.4) Ist $x \in \mathfrak{D}(A_m^*)$ bzw. $\in \mathfrak{D}(A^*)$ und verschwindet x auszerhalb $\mathfrak{o}_n$ $(n \leqq m)$, so tut das auch $A_m^* x$ bzw. $A^* x$.

Beweis: Sei $x \in \mathfrak{D}(A_m^*)$. Nach 2.6.2 und 2.8 existiert $z \in \mathfrak{D}(A)$ mit $P_m z = x$. Wegen 3.1 hat man $P_m A y = A_m^* P_m y = A_m^* x$. Da hier das erste Glied auszerhalb $\mathfrak{o}_n$ verschwindet, tut es auch das letzte. — Sei $x \in \mathfrak{D}(A^*)$. Da dann auch $P_m x = x \in \mathfrak{D}(A_m^*)$ ist, verschwindet, wie eben bewiesen, $A_m^* x$ auszerhalb $\mathfrak{o}_n$, also auch $A^* x = \lim A_n^* x$ (siehe 1.3).

(3.5) $\mathfrak{D}(A_n) \subset \mathfrak{D}(A^*)$.

Beweis: $x \in \mathfrak{D}(A_n)$, $y \in \mathfrak{D}(A)$. $(Ax, y) = (A_n x, y) = (A_n x, P_n y) = (x, A_n^* P_n y) = (x, P_n A y) = (x, Ay)$, und zwar ist das erste Gleichheits-

zeichen trivial, das zweite steht, weil A Ortsoperator ist, das dritte wegen 2.6.2 und 2.8, das vorletzte wegen 3.1, das letzte ist trivial. Wir haben also $x \in \mathfrak{D}(A^*)$.

(3.6) $P_n \mathfrak{D}(A) = P_n \mathfrak{D}(A_{n+1}) = P_n \mathfrak{D}(A^*) = P_n \mathfrak{T}(A)$. $\mathfrak{D}(A^*) \subset \mathfrak{T}(A)$.

Beweis: Die Beziehung zwischen erstem und zweiten Glied steht in 2.8, die zwischen erstem und vierten in 2.9. $P_n \mathfrak{D}(A^*) \subset \mathfrak{D}(A_n^*)$ wegen 1.3, $\subset P_n \mathfrak{D}(A_{n+1})$ wegen 2.6.2, $\subset P_n \mathfrak{D}(A^*)$ wegen 3.5, woraus die Gleichheit von zweitem und drittem Glied folgt. Der Rest ist klar.

(3.7) Ist $x \in \mathfrak{T}(A)$ und verschwindet x auszerhalb eines $\mathfrak{o}_n$, so ist $x \in \mathfrak{D}(A^*)$.

Beweis: Nach 3.6 ist $x = P_{n+1} x \in P_{n+1} \mathfrak{D}(A_{n+2}) \subset \mathfrak{D}(A_{n+1}^*)$, ferner $x = P_n x \in P_n \mathfrak{D}(A_{n+1})$.

Sei $y \in \mathfrak{D}(A)$; dann gibt es $y' \in \mathfrak{D}(A_{n+1})$ mit $P_n y' = P_n y$; da A Ortsoperator ist, hat man dann $P_n A y' = P_n A y$. Es gilt also: $(x, A y) = (x, P_n A y) = (x, P_n A y') = (P_n x, A y') = (P_n x, A_{n+1} y')$. Wegen des ersten Absatzes darf man weiterschreiben: $= (A_{n+1}^* x, y')$. Da x auszerhalb $\mathfrak{o}_n$ verschwindet, verschwindet wegen 3.4 auch $A_{n+1}^* x$ dort. Es ist also $A_{n+1}^* x = P_n A_{n+1}^* x = A_n^* x$ (wegen 2.5). Setzen wir das ein, so haben wir $(x, A y) = (A_n^* x, y') = (A_n^* x, P_n y') = (A_n^* x, P_n y) = (A_n^* x, y)$, woraus die Behauptung folgt.

(3.8) Ist $x \in \mathfrak{D}(A^*)$ und verschwindet x auszerhalb eines $\mathfrak{o}_n$, so gehört x zu jeder Erweiterung von $\mathfrak{D}(A)$, in der A^* maximal hermitesch ist.

Beweis: Sei auch $y \in \mathfrak{D}(A^*)$; dann existiert nach 3.5 ein $z \in \mathfrak{D}(A_{n+1})$ mit $P_n z = P_n y$, und es ist auch $P_n A^* z = P_n A^* y$ (wegen 3.4). $(A^* x, y) = (A^* x, P_n y) = (A^* x, P_n z) = (A^* x, z) = (x, A z) = (x, A^* z) = (x, P_n A^* z) = (x, P_n A^* y) = (x, A^* y)$ (erstes und drittes Gleichheitszeichen wegen 3.4). Das ist aber mit der Behauptung äquivalent.

4. Satz: Zu A gehört (unter den Voraussetzungen von Satz 3) eine in $\mathfrak{D}(A^*)$ definierte hermitesche Form $B(x, y)$, die nur vom Randverhalten der Argumente abhängt, die „Randform" von A, deren maximale Nullstellenräume über $\mathfrak{D}(A)$ *die* Räume über $\mathfrak{D}(A)$ sind, in denen A^* maximal hermitesch ist. Bei der Berechnung der Werte von $B(x, y)$ darf man nicht nur, sondern kann man auch die Argumente durch solche ersetzen, die innerhalb eines beliebigen $\mathfrak{o}_n$ verschwinden.

Man setze nämlich $(A^* x, y) - (x, A^* y) = i B(x, y)$; dann folgt die Aussage ohne weiteres aus 3.

5. Es ist wohl klar, wie die Sätze 3 und 4 bei der Untersuchung von Differentialoperatoren anzuwenden sind; wir gehen darauf hier nicht näher ein.

Mathematics. — *Ueber die Friedrichssche Fortsetzung halbbeschränkter Hermitescher Operatoren.* By HANS FREUDENTHAL. (Communicated by Prof. L. E. J. BROUWER.)

(Communicated at the meeting of June 27, 1936.)

1. Wir geben eine kurze Ableitung der K. FRIEDRICHSschen [1]) selbstadjungierten Fortsetzung halbbeschränkter Hermitescher Operatoren.

$\mathfrak{R}$ sei ein vollständiger unitärer Raum (Hilbertscher Raum ohne Dimensions- und Mächtigkeitsaxiome). H sei ein Hermitescher nach unten beschränkter linearer Operator in ihm (als Schranke nehmen wir etwa 1), H^* sei seine Adjungierte, $\mathfrak{D}$ und $\mathfrak{D}^*$ seien die bzw. Definitionsmengen.

$(Hx, y) = (x, y)'$ ist ein in $\mathfrak{D}$ definiertes „neues" inneres Produkt; für die auf diesem inneren Produkt beruhende „neue" Metrik gilt $|x|' \geqq |x|$; die „neue" Topologie ist also schwächer als die alte. In der neuen Topologie läszt sich $\mathfrak{D}$ vervollständigen zu einem vollständigen unitären Raum $\mathfrak{R}'$. $\mathfrak{R}'$ läszt sich als Teilraum von $\mathfrak{R}$ (mit einer andern Topologie) auffassen, da eine Fundamentalfolge der neuen Topologie aus $\mathfrak{D}$ a fortiori Fundamentalfolge der alten Topologie ist.

Die Formel $(x, y)' = (Hx, y)$ galt definitionsgemäsz für $x, y \in \mathfrak{D}$; aus Stetigkeitsgründen gilt sie aber weiter für $x \in \mathfrak{D}$, $y \in \mathfrak{R}'$.

Wir definieren $\widetilde{\mathfrak{D}}$ als Durchschnitt von $\mathfrak{D}^*$ und $\mathfrak{R}'$ (das ist ein linearer Raum zwischen $\mathfrak{D}$ und $\mathfrak{D}^*$) und $\widetilde{H}$ als das auf $\widetilde{\mathfrak{D}}$ eingeschränkte H^*.

Satz: $\widetilde{H}$ ist selbstadjungiert.

Beweis: 1. Sei $x, y \in \widetilde{\mathfrak{D}}$. Dann gibt es Folgen x_m bzw. y_n aus $\mathfrak{D}$, die in der neuen Topologie nach x bzw. y konvergieren. Es konvergiert dann auch $(x_m, y_n)' = (Hx_m, y_n) = (x_m, Hy_n)$. Der Limes davon ist einerseits gleich

$$\lim_m \lim_n (Hx_m, y_n) = \lim_m (Hx_m, y) = \lim_m (x_m, \widetilde{H}y) = (x, \widetilde{H}y),$$

andererseits gleich

$$\lim_n \lim_m (x_m, Hy_n) = \lim_n (x, Hy_n) = \lim_n (\widetilde{H}x, y_n) = (\widetilde{H}x, y).$$

$\widetilde{H}$ ist also Hermitesch.

2. Sei $x \in \mathfrak{D}$, $y \in \mathfrak{R}$. $|(x, y)| \leqq |y| \cdot |x| \leqq |y| \cdot |x|'$; (x, y) ist also ein überall dicht in $\mathfrak{R}'$ definiertes, im Sinne von $\mathfrak{R}'$ beschränktes lineares Funktional von x, also mit einem geeignetem $y' \in \mathfrak{R}'$ darstellbar in der Form

$$(x, y) = (x, y')' = (Hx, y').$$

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[1]) Math. Ann. **109**, 465—487 (1934). Insbesondere §§ 2—5.

Liest man diese Gleichung in umgekehrter Richtung, so sieht man, dasz (Hx, y') ein für $x \in \mathfrak{D}$ beschränktes Funktional (im Sinne von $\mathfrak{R}$) ist. Also ist y' in $\mathfrak{D}^*$, also auch im Durchschnitt von $\mathfrak{R}'$ und $\mathfrak{D}^*$, also $y' \in \widetilde{\mathfrak{D}}$ und $\widetilde{H}y' = y$. Da y willkürlich in $\mathfrak{R}$ war, bedeutet das $H\widetilde{\mathfrak{D}} = \mathfrak{R}$. Nach J. v. NEUMANN [2]) ist also $\widetilde{H}$ selbstadjungiert.

2. $\widetilde{H}$ hat dieselbe untere Grenze wie H. K. FRIEDRICHS [3]) hat gefragt, ob $\widetilde{H}$ als selbstadjungierte Fortsetzung von H durch diese Eigenschaft charakterisiert sei. Wir verneinen die Frage:

$\mathfrak{R}$ sei direkte Summe der Hilbertschen Räume $\mathfrak{R}_1$ und $\mathfrak{R}_2$; H_1 sei in $\mathfrak{R}_1$ definiert als der identische Operator, H_2 in $\mathfrak{D}_2 \subset \mathfrak{R}_2$ als halbbeschränkter Hermitescher Operator mit der unteren Schranke $\gamma > 1$; H sei die direkte Summe von H_1 und H_2. H_2' sei irgendeine selbstadjungierte Fortsetzung von H_2 in R_2 mit einer zwischen 1 und γ liegenden unteren Schranke. H_2' wird im allgemeinen von $\widetilde{H}_2$ verschieden sein (z. B. wenn $\mathfrak{R}_2$ der Raum der im Einheitsintervall zweimal stetig differenzierbaren Funktionen ist, die in den Endpunkten mit samt ihren ersten Ableitungen verschwinden, und H_2 die Bildung der negativen zweiten Ableitung). H', die direkte Summe von H_1 und H_2', wird dann auch von $\widetilde{H}$ verschieden sein, aber doch dieselbe Schranke wie H (nämlich 1) besitzen und selbstadjungiert sein.

[2]) Math. Ann. **102**, 49—131 (1929). Insbesondere Satz 41.

[3]) a a. O., Fusznote 14.

Chemistry. — *The Exact Measurement of the Specific Heats of Metals at High Temperatures:* **XXV**. *The Specific Heats and the Allotropism of Nickel between 0° and 1000° C.* By M. EWERT. (Communicated by Prof. F. M. JAEGER.)

(Communicated at the meeting of June 27, 1936).

§ 1. The data about the allotropism of *nickel*, as given in the literature [1]), are still rather confusing. Certainly there is a cubic, face-centred *α*-form with $a_0 = 3.518$ A.U. and a density of 8.86 stable at ordinary temperatures to about 350° C. Exactly as in the case of cubic, body-centred *α*-iron at 768° C. and in that of hexagonal *α-cobaltum* at 1105°—1130° C., the change of *α-nickel* at 350°—353° C. from the

[1]) For the literature cf.: F. M. JAEGER and E. ROSENBOHM, Proc. Royal Acad. Amsterdam, **34**, 818 (1931); Rec. d. Trav. d. Chim. Pays-Bas, **51**, 41 (1932).

ferromagnetic into the feebly paramagnetic β-state *is not accompanied by a change in the crystalline structure.* In how far the said transformation which, from the calorimetrical point of view, has the complete character of an allotropic change, really has to be considered as a case of true "allotropism", depends on the definition adopted for the latter phenomenon: here the indication of α- and β-states is given conform to the indication of α- and β-*iron.* Moreover, BREDIG and ALLOLIO [1]) proved that another, closest-packed hexagonal form of *nickel* exists, which already at about 300° C. would be transformed into the ordinary cubic form; this hexagonal α'-*nickel* would have the parameters: $a_0 = 2.684$ A.U. and $c_0 = 4.382$ A.U. and a density of 7.04.

The low density gave rise to the supposition, that these authors really studied a *hydride* of hexagonal *nickel*: indeed, THOMPSON, by means of electron-diffraction experiments, afterwards confirmed the existence of the hexagonal modification, but found: $a_0 = 2.474$ A.U.; $c_0 = 4.06$ A.U. and $d = 8.86$, — which agrees much better with the density of the ordinary cubic form.

Hitherto it was unknown in what relation this hexagonal modification stood with respect to the cubic form. From measurements of the heat-capacity according to SALADIN-LE CHATELIER's twin-galvanometer method [2]) and from analogous determinations of the electrical resistance [3]) and of the thermo-electrical behaviour towards *copper* [4]) as a function of the temperature, JAEGER and ROSEMBOHM drew the conclusion that most probably the hexagonal α'-form of the metal equally is an enantiotropic form, its province of stability being situated between those of the α- and β-states. By this supposition the characteristic peculiarities of the transformation $\alpha \rightleftarrows \beta$-*nickel*, as observed by them and other investigators with respect to the ever more or less "gradual" changes of the physical properties of the metal, would simultaneously find a ready explanation.

The results of the calorimetrical experiments communicated in the present paper now most probably can be considered to prove the exactness of the supposition mentioned: the shape of the Q_0-t-curve clearly

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[1]) G. BREDIG and R. ALLOLIO, Zeits. phys. Chem., **126**, 41 (1917); G. BREDIG und E. SCHWARZ VON BERGKAMPF, ibidem, BODENSTEIN-Bnd, 172 (1931); W. BÜSSEM und F. GROSS, Zeits. f. Phys., **87**, 778 (1934); E. R. JETTE, V. H. NORDSTROM, B. QUENAU und F. FOOTE, Amer. Inst. Min. Met. Engin. Publ. N°. 522 (1934); F. MARSCHAK und D. STEPANOW, Zeits. f. Electrochem., **41**, 599 (1935); G. P. THOMPSON, Proc. Royal Soc. London, A, **125**, 352 (1929); M. C. NEUBERGER, *Die Allotropie der Chem. Elemente,* Stuttgart, 22, 23 (1936); S. B. HENDRICKS, M. E. JEFFERSON und J. F. SCHULTZ, Zeits. Kryst., **73**, 378, 379 (1930); L. VEGARD und H. DALE, *ibidem,* **67**, 157 (1928); S. VALENTINER und G. BECKER, *Naturwissenschaften,* **17**, 639 (1929); L. R. INGERSOLL und J. D. HANAWALT, Phys. Rev. **34**, 972 (1929); L. MAZZA und A. G. NASINI, Phil. Mag., **7**, 301 (1929).

[2]) E. ROSENBOHM and F. M. JAEGER, Proc. Royal Acad. Amsterdam, **39**, 372 (1936).

[3]) Idem, Proc. Royal Acad. Amsterdam, **39**, 380 (1936).

[4]) Idem, Proc. Royal Acad. Amsterdam, **39**, 477 (1936).

demonstrates that the field of stable existence of the hexagonal α'-form lies between 345° and 351° C. As the transformations $\alpha \rightleftarrows \alpha'$- and $\alpha' \rightleftarrows \beta$-*nickel* are rather *slow*, truly reproducible values of $\bar{c}_p$ for the α'-form can only be obtained, if the metal has previously been heated at the constant temperature of $t°$ C. *during a sufficiently long time*: otherwise the values of $\bar{c}_p$, — and also of other physical properties, — evidently correspond only to more or less *in*definite "intermediate" states. In the Table the latter values are marked with an asterisk. The specific heats of the α'-modification, within its field of stability, can equally well be determined when starting with the α-, as with the β-state of the metal, — a fact which proves the truly reversible character of these transitions.

§ 2. Purest *nickel* in small lumps of pea-size[1]) was melted and then slowly cooled in the high vacuum of an induction-furnace. The mass obtained was turned off on the lathe and shaped in the form of a conus fitting within the platinum vacuum-crucibles always used in the calorimetrical work of this laboratory. The *nickel*-block weighed 44.0500 grammes, the platinum crucible 25.8848 grammes. The maximum temperature of the calorimeter-block in all experiments was reached in about 5 minutes after the crucible had been dropped into the instrument. In the beginning the solidified metal proved not yet completely to have been stabilized; but heating at 600° C. during a long time resulted in the establishment of its stabilized condition. All data obtained are collected in the following table; for the reduction Q to Q_0, as the most probable value of $\bar{c}_p$ between 20° and 0° C.: $\bar{c}_p = 0.1024$ was made use of.

§ 3. From these data we can calculate the quantities of heat Q_0 developed by 1 gramme of *nickel* between 0° and 350° C. with a fair degree of accuracy by means of the formula:

$$Q_0 = 0.10115 \,.\, t + 0.56282 \,.\, 10^{-4} \,.\, t^2 + 0.1313 \,.\, 10^{-7} \,.\, t^3.$$

The positive or negative deviations between the values observed and calculated with the aid of this formula prove to be distributed at random and never to exceed 0.5 to 2.5 pro mille; the agreement, therefore, is sufficiently accurate.

The true specific heats C_p can, within this interval of temperatures, be expressed by:

$$c_p = 0.10115 + 0.112564 \,.\, 10^{-3} \,.\, t + 0.3939 \,.\, 10^{-7} \,.\, t^2,$$

and the atomic heats C_p by:

$$C_p = 5.9356 + 0.66053 \,.\, 10^{-2} \,.\, t + 0.231142 \,.\, 10^{-5} \,.\, t^2.$$

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[1]) Furnished by Dr. FRAENKEL and Dr. LANDAU, Berlin-Oberschöneweide.

TABLE I.

Mean Specific Heats of Nickel between 0° and 1000° C.

No of the Experiment:	Temp. t in ° Cent.:	Quantity of Heat Q developed by 1 gramme of nickel between $t°$ and t' in Calories:	Quantity of Heat Q_0 developed between $t°$ and 0° C. in Calories:	Mean Specific Heat $\bar{c}_p$ in Calories:
60	196°.5	19.96	22.15	0.1140
56	251.2	27.02	29.17	0.1174
41	298.8	33.37	35.58	0.1203
20	299.0	33.36	35.52	0.1200
21	323.2	36.83	39.03	0.1221
42	326.0	37.21	39.43	0.1223
18	335.9	38.67	40.91	0.1231
22	340.6	39.28	41.50	0.1232
47	343.8	39.60	41.83	0.1230
48	343.8	39.75	41.98	0.1234
40	344.4	39.79	41.99	0.1233
49	344.4	39.82	42.05	0.1234
24	345.1	39.81	42.04	0.1234
50	345.1	40.14	42.33	0.1240
51	345.5	40.11	42.25	0.1236
*43	346.7	40.15	42.37	0.1236
26	346.0	40.12	42.34	0.1237
*54	346.8	40.11	42.35	0.1235
55	346.8	40.26	42.50	0.1239
*52	346.9	40.11	42.33	0.1234
25	347.6	40.39	42.59	0.1239
45	348.3	40.48	42.69	0.1239
46	348.3	40.57	42.80	0.1242
*36	348.5	40.39	42.62	0.1236
44	349.1	40.64	42.81	0.1239
37	349.4	40.60	42.83	0.1240
35	349.9	40.72	42.93	0.1240
23	349.8	40.84 (?)	43.07 (?)	0.1245
33	350.25	40.74	42.97	0.1240
*31	350.5	40.60	42.82	0.1235
32	350.8	40.78	43.01	0.1240
*30	351.3	40.83	43.02	0.1238
39	351.6	41.05	43.24	0.1243
38	352.8	41.22	43.45	0.1245
29	352.9	40.82 (?)	43.06 (?)	0.1233
28	354.8	41.30	43.53	0.1240
27	360.0	42.19	44.42	0.1248
53	383.9	45.36	47.60	0.1250
34	428.8	50.95	53.13	0.1251
17	599.5	71.18	73.44	0.1261
57	700.6	85.82	88.14	0.1266
58	804.9	99.54	101.97	0.1274
59	948.5	118.70	121.14	0.1284

The initial observations, made with the not yet stabilized metal, are omitted in this table.

Some of the values of c_p and C_p thus calculated are the following:

t:	c_p:	C_p:
100°	0.1128	6.619
150	0.1189	6.978
200	0.1252	7.349
250	0.1318	7.734
300	0.1385	8.125
345	0.1448	8.495

The increase of C_p with the temperature is remarkably steep, as can be seen from the C_p-t-curve for the α-modification graphically represented in Figure 1.

The specific heats of the α'-modification, on the other hand, can between 345° C. and 351° C. be represented by the formula:

$$c_p = 0.10321 + 0.1111 \,.\, 10^{-3} \,.\, t,$$

and its atomic heats C_p by:

$$C_p = 6.0563 + 0.65193 \,.\, 10^{-2} \,.\, t;$$

so that C_p is at 345° C.: 8.305 and at 351° C.: 8.335. (Fig. 1.)

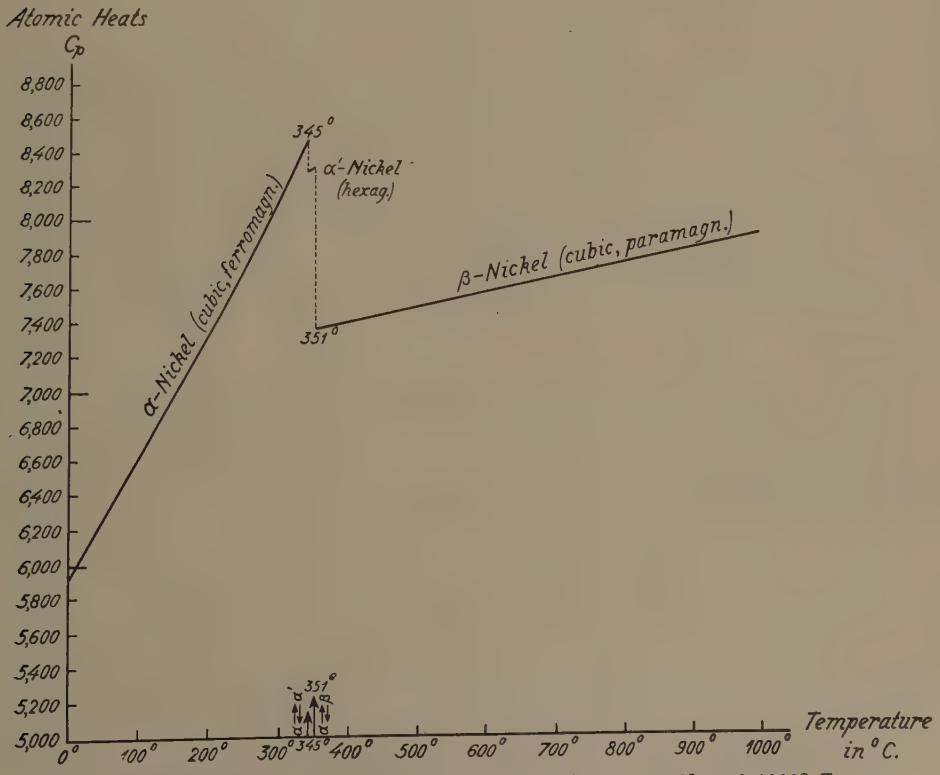

Fig. 1. *The true Atomic Heats C_p of Nickel between 0° and 1000° C.*

The specific heats of β-nickel can, between 360° and 1000° C., be represented by the formula:

$$c_p = 0.1261 + 0.1449 \,.\, 10^{-4} \,(t - 360),$$

and its atomic heats, therefore, by:

$$C_p = 7.39967 + 0.85028 \,.\, 10^{-3} \,.\, (t - 360).$$

Some of the values of c_p and C_p thus calculated, are as follows:

t:	c_p:	C_p:
360°	0.1261	7.400
400	0 1267	7.435
500	0.1281	7.517
600	0.1295	7.617
700	0.1310	7.687
800	0.1324	7.769
900	0.1339	7.857
1000	0.1354	7.945

The C_p-t-curve for *β-nickel* is simultaneously reproduced in Figure 1; evidently its slope is much less steep than in the case of the α-form.

As to the heats of transformation at the transition-temperatures, it can approximately be deduced from the previous data that the heat-effect of the transformation: $\alpha \rightleftarrows \alpha'$ at 345° C. must be of the order: 0.08 cal.; that of the transformation $\alpha' \rightleftarrows \beta$-*nickel* at 351° C. of the order: 0.31 cal. pro gramme; so that he heat of transformation: $\alpha \rightleftarrows \beta$-form is about: 0.39 calories pro gramme at 345°—350° C. —

These measurements were executed in the *Laboratory for Inorganic and Physical Chemistry* of the University of *Groningen*. I hereby wish to express my sincere thanks to Prof. Dr. F. M. JAEGER, director of the said laboratory, and to his assistants, Dr. ROSENBOHM and Dr. BOTTEMA, for their interest and their kind help during my work on this subject.

Groningen, May 1936.

Meteorology. — *Meteorologisches zu den 3 holländischen Karakorum-Expeditionen.* II. Von W. BLEEKER. (Communicated by Prof. E. VAN EVERDINGEN.)

(Communicated at the meeting of May 23, 1936).

IV. *Bewölkung und Wolken.*

Nachfolgende Zahlen geben die mittlere Himmelsbedeckung in den verschiedenen Monaten:

Juni	I	II	III (1929)	III (1930)	III	I und III
Morgen	0.63 (6)	0.24 (30)	0.47 (24)	0.67 (30)	0.58 (54)	0.59 (60)
Mittag	0.68 (6)	0.44 (30)	0.59 (22)	0.68 (26)	0.64 (48)	0.64 (54)
Abend	0.42 (6)	0.29 (30)	0.32 (24)	0.72 (30)	0.54 (54)	0.53 (60)
Mittel	0.64	0.32	0.46	0.69	0.59	0.59

Juli	I	II	III (1929)	III (1930)	I und III
Morgen	0.43 (31)	0.47 (31)	0.69 (30)	0.56 (28)	0.56 (99)
Mittag	0.44 (31)	0.40 (31)	0.64 (25)	0.43 (24)	0.50 (80)
Abend	0.25 (31)	0.31 (31)	0.56 (31)	0.51 (28)	0.44 (90)
Mittel	0.37	0.39	0.63	0.50	0.50

August	I	II	III (1929)	I und III
Morgen	0.38 (31)	0.56 (31)	0.41 (31)	0.40 (62)
Mittag	0.44 (31)	0.54 (31)	0.47 (27)	0.45 (58)
Abend	0.31 (30)	0.43 (31)	0.28 (30)	0.30 (60)
Mittel	0.38	0.51	0.39	0.38

September	I	II	III (1929)
Morgen	0.36 (30)	0.38 (30)	0.21 (30)
Mittag	0.53 (24)	0.55 (30)	0.54 (29)
Abend	0.40 (30)	0.42 (30)	0.37 (30)
Mittel	0.43	0.45	0.37

Sommer	Hunza	Ost-Karakorum
Morgen	0.42 (92)	0.52 (211)
Mittag	0.46 (92)	0.52 (192)
Abend	0.34 (92)	0.42 (210)
Mittel	0.41	0.49

Aus allen drei Expeditionen:

	Morgen	Mittag	Abend	Mittel
Juni	0.47 (90)	0.57 (84)	0.45 (90)	0.50
Juli	0.54 (120)	0.47 (111)	0.40 (121)	0.47
August	0.45 (93)	0.48 (89)	0.34 (91)	0.42
Sept.	0.33 (90)	0.54 (83)	0.40 (90)	0.41
Juni—Sept.	0.45 (393)	0.51 (367)	0.40 (392)	0.45

Die Werte variieren zwischen 2.5 und 7 Zehntel. Die Unterschiede für

dieselben Gebiete sind ziemlich gross (Juni 1929: 0.46, Juni 1930: 0.66, Juli 1922: 0.37, Juli 1929: 0.63).

Im Juni und Juli ist die Bewölkung im Ost-Karakorum grösser als im Hunza, im August umgekehrt; das Sommermittel gibt für das Hunza-Gebiet niedrigere Zahlen. Soweit die Bewölkung durch niedrige Wolken verursacht wird, ist diese Tatsache in Zusammenhang zu bringen mit der grösseren relativen Feuchtigkeit im Ost-Karakorum. Dass trotz der geringen Himmelsbedeckung die Mittagstemperaturen im Hunza tiefer sind, weist wieder auf die orographischen Effekte hin.

Im September ist im Hunza-Gebiet die grösste, im Aghil die geringste Himmelsbedeckung zu verzeichnen.

Fasst man alle drei Expeditionen zusammen, so ist der Juni der trübste Monat, August und September sind die heitersten Monate.

Im allgemeinen sind die Abende am heitersten, die Konvektion bringt die höheren Mittagszahlen, welche im Sommer nur wenig von den Morgenmitteln abweichen.

Wir haben weiters für den Sommer in den beiden Gebieten und für die verschiedenen Monate für alle 3 Expeditionen die Anzahlen der heiteren und trüben Tage ausgezählt (heiter: mittlere Bewölkung < 2 trüb: > 8 Zehntel).

Sommer	Heiter	Trüb
Hunza	28	13 % aller Beobachtungstage
E-Karakorum	22	24 % „ „
Drei Expeditionen:		
Juni	19	24 % „ „
Juli	25	20 % „ „
August	28	17 % „ „
September	32	11 % „ „

Mit Rücksicht auf die Bewölkung hat WAGNER [1]) Recht, wenn er den September, der nur 11 % trübe Tage hat, für eine Bezwingung höher Berggipfel sehr günstig hält.

Leider ist die Wolkenart bei der ersten Expedition gar nicht, bei der zweiten und dritten nur dann und wann notiert worden; aus den Sommermonaten mit 700 Beobachtungsterminen liegen nur 153 Beobachtungen hierüber vor, nämlich:

Cu.	Cunb.	Stcu.	St.	Nb.	Acu.	Cist.	Cicu.	Ci.	
21	12	11	15	32	18	15	11	18	Mal.

Vermutlich hat die Bezeichnungsweise den Beobachtern Schwierigkeiten bereitet.

Auf Grund von Vergleichen mit den Höhen der Berge konnten auch Wolkenhöhen aufgezeichnet werden; es hat aber keinen Zweck, hierfür Mittel zu geben; doch wurden die Zahlen bei der Bestimmung der Windrichtung in verschiedenen Niveaus benutzt.

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[1]) A. WAGNER. l.c.

V. *Wind.*

Ziemlich regelmässig wehten in den Beobachtungsgebieten lokale Tal- und Hangwinde, die jedoch nicht selten von kräftiger Windentwicklung bei Schauer, manchmal auch von Strömungen der freien Atmosphäre gestört wurden; dagegen war auf den Gletschern meist den ganzen Tag die Luftversetzung talabwärts gerichtet (Gletscherwinde!).

Fassen wir die Windbeobachtungen aller Höhen ohne Rücksicht auf die Lage des Beobachtungsortes (Tal, Hang, Gipfel, Gletscher) zusammen und nennen wir die Bewegung talaufwärts positiv, talabwärts negativ, so finden wir für den Sommer:

	Morgen	Mittag	Abend
Hunza	—0.7	0.7	—0.9 mps.
Ost-Karakorum	—1.1	0.0	—1.5 mps.

Die Schwankungen sind ungefähr gleich gross; im Ost-Karakorum ist der Talwind stärker, der Bergwind schwächer entwickelt als im Hunza.

Die Beobachtungen der Windgeschwindigkeit wurden mittels eines Fuess-Anemometers gemacht.

Die Notizen über die Zugrichtung der Wolken ermöglichen eine Beurteilung der Strömung der freien Atmosphäre. Diese Beobachtungen der Höhenwinde sind nach der LAMBERTschen Formel bearbeitet worden; die nachstehenden Mittelwerte der Richtung und Beständigkeit sind aus den Tagesmitteln berechnet, damit nicht die trüben Tage mit drei Beobachtungen gegenüber die heiteren Tage mit nur einer oder zwei Beobachtungen einen verhältnismässig zu grossen Einfluss auf die Mittelwerte bekamen. Es stehen von fast jedem Reisetage Beobachtungen zur Verfügung. Für den Sommer finden wir bei Zusammenfassung aller Expeditionen in verschiedenen Wolkenniveaus:

	Richtung.	Beständigkeit.
Niedrig (bis 5000 m)	240°	0.71
Mittel (5000—7000 m)	250°	0.71
Hoch (ab 7000 m und Ci.)	240°	0.56

Die Luftbewegung ist also in allen Niveaus praktisch dieselbe. Merkwürdig ist, dass die Beständigkeit in den höheren Schichten kleiner ausfällt; diese Erscheinung könnte mit dem auf Seite 750 erwähnten abnehmenden Geschwindigkeit des Westwindes mit der Höhe in Zusammenhang stehen.

Fassen wir alle Beobachtungen ohne Rücksicht auf die Wolkenhöhen zusammen, dann ergibt sich im Sommer für:

	Richtung.	Beständigkeit.
Ost-Karakorum	243°	0.70
Hunza	264°	0.51

Die prozentuellen Frequenzen der Hauptwindrichtungen (N =

$= \frac{1}{2}$ NNW + N + $\frac{1}{2}$ NNE, NE $= \frac{1}{2}$ NNE + NE + $\frac{1}{2}$ ENE, usw.) sind:

Ost-Karakorum:				Hunza:			
N	5 %	S	14 %	N	14 %	S	9 %
NE	1 %	SW	40 %	NE	2 %	SW	27 %
E	2 %	W	29 %	E	4 %	W	29 %
SE	1 %	NW	8 %	SE	3 %	NW	13 %

Im Ost-Karakorum ist die vorherrschende Luftbewegung SW, im Hunza W; die Beständigkeit ist im Ost-Karaborum etwas grösser als im Hunza. Diese Ergebnisse fügen sich gut in die Strömungslinien für *grösseren* Höhen, welche WAGNER wie erwähnt für Indien gezeichnet hat [1]); ein Teil von WAGNERs Karte für *6000 m* ist hier reproduziert (Fig. 3). Extrapolierend hätte man wirklich für das weiter östlich gelegene Karakorum-Gebiet in dieser Höhe eine stärkere Süd-Komponente erwartet als für Hunza.

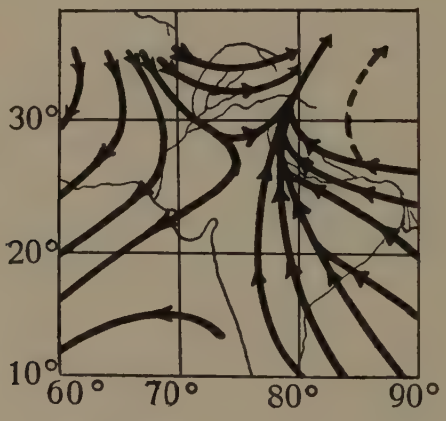

Fig. 3. Strömungslinien in 6000 m nach WAGNER [1])

Die verschiedenen Monate geben (alle drei Expeditionen zusammen):

	Richtung.	Beständigkeit.
Juni	265°	0.63
Juli	241°	0.64
August	241°	0.67
September	236°	0.66

Im Juni ist die Strömung W, in den späteren Monaten WSW bis SW. Wenn man unter SW-Monsun eine von der Jahreszeit abhängige Luftströmung vom Meer ins Land hinein versteht, so kann man in diesen Gegenden nicht mehr von Monsun sprechen. Das Windsystem muss zu den westlichen Winden der höheren Breiten gehören. WAGNERs Karten geben im Winter in 3000 m eine etwas nördlichere Strömung; die Herbst-, Winter- und Frühlings-Werte der *dritten* Expedition geben als Mittel

[1]) WAGNER. l.c.

bzw. 250°, 275°, 275°; sie sind zwar aus *höheren* Breiten, schliessen aber gut an die Sommermittel an. Das beweist, dass von einem Wechsel der Windrichtungen keine Rede ist, wenn auch im Sommer und Herbst Winde aus südlichen Richtungen etwas häufiger sind.

Ziemlich merkwürdig ist der tägliche Gang des Windes, der besonders in den Morgen- und Mittag-Werten zum Ausdruck kommt. Zur richtigen Beurteilung der Realität dieses täglichen Ganges wurden nur von jenen Tagen, von welchen sowohl Morgen- als auch Mittag-Beobachtungen zur Verfügung standen, die Mittel berechnet. Für den Morgen ergibt sich 231° mit 0.65, für den Mittag 246° mit 0.69 Beständigkeit.

Aus der Rechtsdrehung des Windes vom Morgen zum Mittag könnte man schliessen, dass die Beobachtungen nicht aus der freien Atmosphäre stammen, weil doch sonst die grösseren Konvektion des Mittags dort eine Linksdrehung bei fortschreitender Tageszeit bewirken müsste. Als eine zweite Erklärungsmöglichkeit für die Rechtsdrehung des Windes vom Morgen zum Mittag, sei angedeutet, dass diese Rechtsdrehung, welche gleichbedeutend ist mit einer Zusatz-Komponente aus NW mit der Ausgleichströmung zwischen Hoch- und Tiefebene zusammenhangen könnte [1]). Es ist aber nicht ohne weiteres zu entscheiden, welche Richtung diese Ausgleichströmung bei dem komplizierten Bau der Hochebene und die Anwesenheit zweier Tiefebenen — einer im Westen und einer im Süden — haben sollte.

VI. *Niederschlag.*

Regen und Schnee, zwei wichtige Faktoren für die Ernährung der Flüsse und Gletscher, lassen sich bei einer ständig den Ort wechselnden Expedition nur schwerlich messen.

Die Notizen, die Niederschläge betreffend, lehren folgendes:

Anzahl Niederschlagstage für alle drei Expeditionen

Juni	49 %	aller Beobachtungstage.
Juli	32 %	„ „
August	37 %	„ „
September	32 %	„ „

Der Juni hat die grösste Anzahl Niederschlagstage zu verzeichnen. Besonders der Juni 1930 war im Aghil sehr reich an Niederschlagstagen (22) meist aber mit leichten Schauern; im Juli 1930 wurden nur 7 Niederschlagstage aufgezeichnet, doch waren die Wetternotizen in diesem Monat spärlich, sodass möglicherweise diese Trockenheit nur vorgetäuscht und durch den verringerten Eifer der Beobachter verursacht ist; dadurch mag auch die prozentuelle Häufigkeit der Regentage in diesem Monat etwas zu niedrig ausgefallen sein. Der September ist dann der trockenste Monat.

Der Sommer bringt im Ost-Karakorum an 42 %, im Hunza an 29 %

[1]) Siehe u.a. WAGNER. Hangwind, Ausgleichströmung, Berg- und Talwind. Met. Zs. 49, Seite 209 (1932).

der Beobachtungstage Niederschlag. Der Gang der Niederschlagstage der verschiedenen Monate ist parallel der relativen Feuchtigkeit in grösseren Höhen (siehe Seite 755, Zone C), man findet ihn auch in der Bewölkung und der Anzahl der trüben Tage. Dass das Hunza-Gebiet trockener ist als das östliche Karakorum-Gebiet kommt, wie wir gesehen haben, auch in der relativen Feuchtigkeit und in der Bewölkung zum Ausdruck.

Von den sommerlichen Niederschlägen fielen:

zwischen:	0—6	6—12	12—18	18—24 Uhr,
	28	24	32	16 %

Die Niederschläge am Nachmittag fallen meistens als leichter Regen oder Graupel. Die grössten Niederschlagsmengen bringt die Nacht, bei den dann herrschenden niedrigen Temperaturen vielfach als Schnee.

Die prozentuelle Verteilung der Hauptwindrichtungen bei Niederschlag stellt sich folgendermassen dar:

N	9 %	SW	39 %
NE	1 %	W	24 %
E	—	NW	4 %
SE	2 %	?	7 %
S	14 %	—	—

Danach bringen die West- und besonders die Südwest-Winde in den von uns betrachteten Gebieten die meisten Niederschläge. In dem an Niederschlagstagen so reichen Juni 1930 traten im Aghil die Schauer öfters bei Winden aus nördlichen Richtungen auf.

Es wäre wünschenswert, wenn man beurteilen könnte, ob die Niederschläge mit den Depressionen oder wenigstens den Fallgebieten der nördlichen Breiten zusammenhängen. Leider gestatten aber nicht einmal die russischen Wetterkarten eine solche Prüfung. Um nun wenigstens eine ungefähre Vorstellung über diese Beziehungen zu bekommen, verglichen wir Luftdruckbeobachtungen im Panamik-Lager (3800 m) von einem Ladakki gemacht mit den Wetternotizen von Dr. VISSER während der Zeit, da dieser sich in nicht allzu grosser Entfernung vom ortsfesten Ladakki-Beobachter befand. Fallender Luftdruck brachte immer zunehmende Bewölkung und Linksdrehung des Windes; bei tiefem Barometerstand fiel Niederschlag, steigender Luftdruck brachte Rechtsdrehung des Windes. In Figur 4 ist das Passieren einer Störung zwischen 29 Juni und 10 Juli graphisch dargestellt. Die Amplitude der Luftdruckänderung betrug 7 mm in 3820 m Höhe, in der Niederung wäre sie ohne Zweifel noch grösser gewesen. Aus den „Indian Daily Weather Reports" geht hervor, dass die Stationen Peshavar, Gulmarg, Gilgit, Srinagar, Skardu, Dras, Leh und Simla gleichfalls diese Luftdruckänderung registrierten. Wahrscheinlich ist sie langsam von West nach Ost gezogen, das scharfe Maximum z. B. findet man in Peshavar am 8., in Simla am 10. Juli. Die Amplitude wird nach Süden hin kleiner. Deutlich sieht man in der Figur, wie die westlichen und westsüdwestlichen Winde vom 1., 2. und 3. Juli am 4. auf SSW zurückfallen, um beim Steigen des Baro-

meters erst in Südwest, dann West und Westnordwest überzugehen. Aus dem heiteren Föhnzustand kann man veilleicht auf Drehung nach

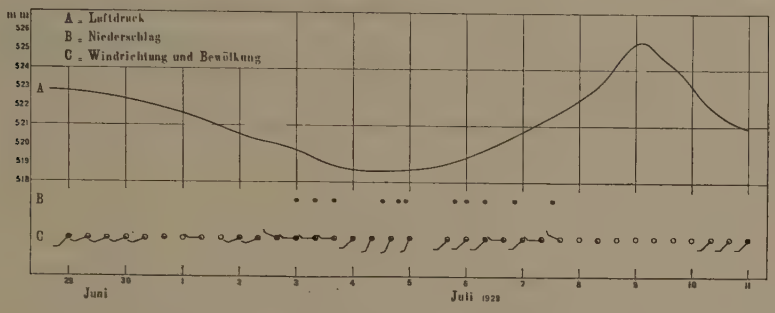

Fig. 4. Störung zwischen 29 Juni und 10 Juli 1929.

NW schliessen. Alle Anzeichen weisen also auf eine von West nach Ost ziehende Depression nördlich vom Beobachtungsgebiete hin.

Uebrigens hat auch TRINKLER auf die Möglichkeit hingewiesen [1]), dass der Niederschlag an der Nordseite der zentral-asiatischen Gebirgen ganz allgemein von den west-ostwärts ziehenden Tiefdruckgebieten herrührt.

Die Depressionen oder die Fallgebiete geben Anlass zu orographischen Niederschlägen, bei ihrer Annäherung verlieren die südlichen Winde an den südlichen Gebirgsketten ihren Wassergehalt, während beim Abziehen die nördlichen Winde im nördlichen Gebirge Stau-Niederschlag verursachen.

VISSER hat das in der Vergletscherung bestätigt gefunden, wie aus Folgenden hervorgeht.

Bei den im Sarikol, nördlich vom Karakorum gelegenen Ketten, welche ungefähr gleiche mittlere Jahrestemperatur (Schneegrenze fast überall in derselben Höhe), gleiche Gebirgsformation und gleiche Streichrichtung haben, nimmt die Vergletscherung von Norden nach Süden ab, obwohl die Gebirgshöhe von Norden nach Süden zunimmt. Wahrscheinlich darf man daraus schliessen, dass die schneebringenden Winde eine nördliche Komponente haben. In der östlichen Fortsetzung des Sarikol, Aghil, nimmt die Vergletscherung nach Osten zu regelmässig ab. Das ist gewiss der höheren Temperatur und der geringeren Gebirgshöhe zuzuschreiben. Es könnte aber darauf hinweisen, dass die Winde aus westlicher Richtung allmählich trockener werden. Beide Tatsachen deuten darauf hin, dass in den nördlichen Gebirgen die Nordwestwinde als die niederschlagbringenden Winde angesehen werden müssen.

Im Saltaro-Karakorum und auch im Karakorum beweisen die nach dem Norden überhängenden Schneegwächten, dass im Sommer die schneebringenden Winde aus südlicher Richtung kommen.

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[1]) TRINKLER und DA TERRA. Wissenschaftliche Ergebnisse der Zentral-Asien-Expedition. Berlin (1932).

(Fortsetzung folgt)

Botany. — *Concerning the influence of temperature treatment on the carbohydrate metabolism, the respiration and the morphological development of the tulip.* I. By L. ALGERA. (Communicated by Prof. J. C. SCHOUTE.)

(Communicated at the meeting of June 27, 1936).

INTRODUCTION.

From the researches of Prof. BLAAUW and others (3, 4, 6, 7, 8, 9 and 10) and of Prof. VAN SLOGTEREN and BEIJER (1 and 2) it has been clearly proved that the temperature affects in a complicated way the velocity of the morphological development. In this development two phases can be distinguished. In the first phase the formation of stem, leaves and flower predominates; in the second phase the extension of the organs formed takes place. With the tulip, the young plant already begins to form its first leaves in the bulb before the lifting-time early in July. After the lifting it continues doing so. The most rapid course of this process is at 17—20° C. With the application both of higher as well as of lower temperatures, the velocity of the formation diminishes. Thus the velocity at 13° C. is about as great as at 23° C.; at 9° C. it is between the velocity at 25.5° C. and 28° C. Through this, lots which have been treated quite differently will be in the same stage of development. Notwithstanding the great morphological conformity there exists however a large difference physiologically, as the plants after the same after-treatment behave quite differently. Forced into bloom under the same conditions, one lot can yield good flowers, whereas the other fails entirely. Hence it follows, that when asked if one can proceed with the cooling of the lot, one may not depend exclusively on the morphological development stage.

Fig. 1 gives a clear impression of the influence of the temperature on the second stage, viz; the extension of the plant. This figure applies to a parcel of tulips of the variety of Le Nôtre of the season 1934—1935. After having been lifted all the bulbs were first placed in a temperature of 20° C. At stage VI being reached, at which stage all the organs except the pistil had been formed, the parcel was divided on 17th August. One part remained in 20° C., the remainder of the bulbs were transferred to 17, 13, 9 or 5° C.

Figure 1 shows that up to planting on 9th October, the stretching is always fastest at 13° C. During all that time the temperature optimum for stretching is therefore at 13° C. The optimum is clearly lower here than the optimum for the organic formation. One cannot see from the figure where the optimum lies after planting, because the lots mentioned here were all planted in the open and therefore only underwent one temperature treatment. From the fact however, that in January and later, the plants in the hot-house at 13° C. grew less rapidly than at 15° C., at 20° C. again

quicker than at 15° C. etc., it appears that the temperature optimum in the meantime had shifted to a higher temperature.

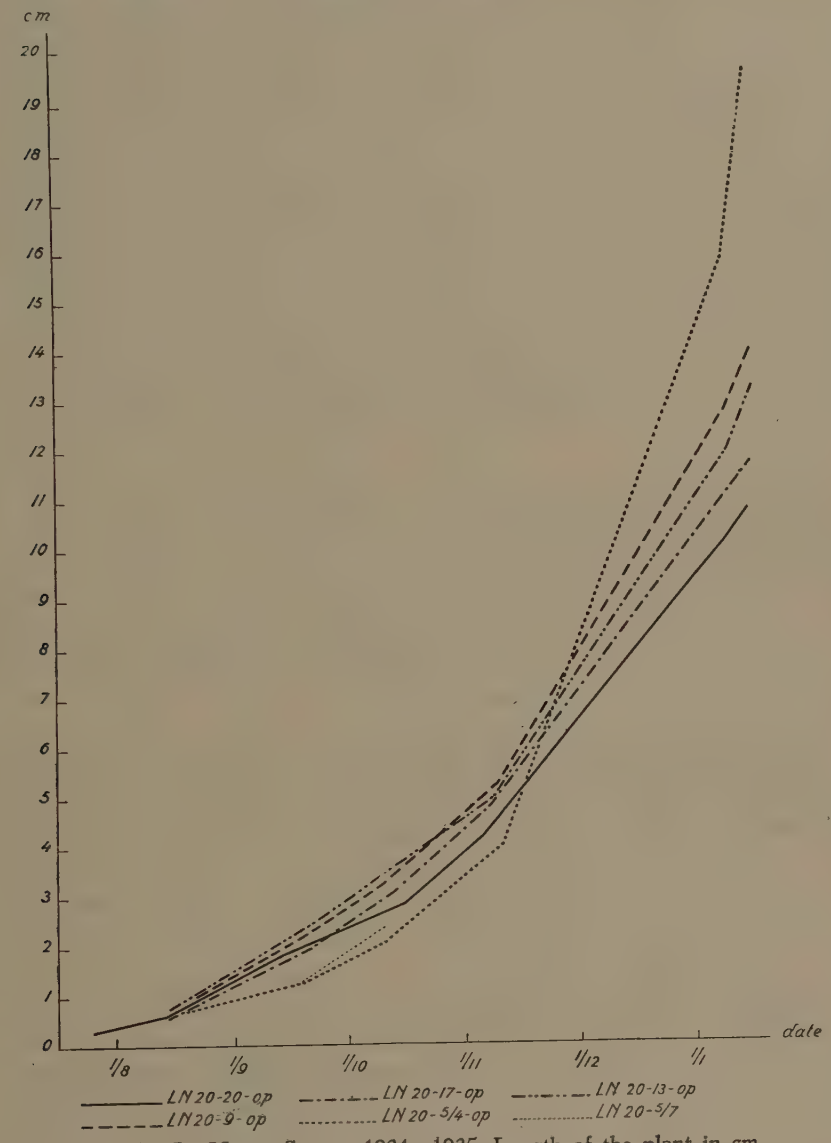

Fig. 1. Le Nôtre. Season 1934—1935. Length of the plant in cm.

One is inclined to infer from the above, that the quickest development is always reached by keeping the bulbs at those temperatures through which at every time the quickest extension takes place. This is however not the case, primarily because the temperature not only has a momentary influence, but can also have after-effects. This is already apparent from fig. 1. Although the lots planted in the open were in the same temperature, all of the plants did not however grow as rapidly. After some time the stretching is quicker according to the degree of cooling of the bulbs before

planting. On the 9th January, probably earlier, the state is as follows, the plant has become longer in proportion to the summer treatment being cooler.

That after-effect also reveals itself in the velocity by which the optimum shifting takes place. The cooler the bulbs have lain, the quicker the optimum rises to a higher temperature. It already appears from the following, that a parcel of bulbs which has had a warm treatment during the summer and for instance was placed early in December in the hot-house at 20° C. stretches only a little quicker than in the much colder outside temperature, while the extension of a lot, which was cooled during the summer, at 20° C. stretched much faster than in the open. This proves that the temperature optimum for stretching is much lower in the former case than in the latter.

Due to the after-effect, the bulbs have to be kept in a cooler place during the summer than in accordance with their optimum in that period so as to obtain the quickest and earliest flowering. The retard in extension, caused thereby is amply recovered later on through the after-effect of the temperature.

In this sense HARTSEMA, LUYTEN and BLAAUW (6) are right when they call the temperatures optimal which are discussed on pages 31—35, and graphically represented in fig. 10. In their totality i.e. paying attention to the ultimate result they effect the quickest growth. It is however not correct that during the summer months the young plant extends itself quickest at 9° C. or even at 5° C. In this period the optimum is at about 13° C. Therefore it would have been better not to speak of optimal temperatures but of an optimal treatment.

We have thus seen that the optimum for the stretching, commencing at about 13° C. shifts to higher temperatures in the course of the season. It is self-evident to assume that this shifting is due to particular factors which at first check the growth at a higher temperature. The extension is namely not only dependent on the temperature but also on the quantity of food available in the bulb, for as long as the young plant cannot assimilate it is entirely dependent on the bulb.

From the research of PINKHOF (11) it appears, that the temperature influences the chemical composition. Cooling during the summer causes a decomposition of the starch and an increase of the quantity of non-reducing sugars. Presumably then there is a parallelism between the changes in the carbohydrate percentage and the internal development.

The research commenced by PINKHOF at the instigation of Prof. VAN SLOGTEREN has been gone into further and in this and a following publication, the principal results of the research of the influence of the temperature during the stretching phase on the carbohydrate metabolism will be set forth. In the latter publication too, the influence which temperature has on the respiration of the bulbs will be discussed. In a third publication, by means of data obtained so far, we shall try to find an explanation for the influence of the temperature treatment on the velocity of the morphological development.

THE CARBOHYDRATE METABOLISM.

Strictly taken, it is perhaps necessary to be acquainted with the entire metabolism of the bulbs in order to attain the object in view. As however this consists of about 80 % of carbohydrates, it seemed desirable to commence the investigation on this group of substances and to investigate how far a satisfactory solution can be obtained through this.

The following carbohydrates were determined: the reducing and the non-reducing sugars and the starch. The method according to which these substances were determined is the same as described by PINKHOF (11).

In the season of 1934—1935 moreover the quantity of sucrose was determined by means of invertase according to COOKE's method (5).

All these substances were expressed in per cents of the dry weight.

All the determinations were performed by Miss A. L. C. VAN WAVEREN. My grateful thanks to her for the work done in connection with this, which she carried out with precision.

The tulip varieties of Murillo and Le Nôtre will be discussed which in the seasons of 1929—1930, 1934—1935 resp., were subjected to various temperature treatments. With Murillo at first only the bulb was examined, from 7th October, moreover the young plants too. However, the bulb will only be discussed here. With Le Nôtre, bulb and plant were as a rule analysed collectively; with a couple of parcels individually.

Murillo. Season 1929—1930.

The research commenced on 6th May, i.e. about two months before lifting. On 1st July nearly all the bulbs were lifted; the remainder 10th July (Table I). Up to July the whole parcel was therefore in the open under

TABLE I.

MURILLO. Season 1929—1930. Survey of the temperature treatment applied.

Lot	Lifting date	Treatment					Planting-date
		1/7—22/7	22/7—1/8	1/8—17/9	17/9—5/11	5/11-end of the determin.	
M 3 w 17—9—9	1—7—'29	17	9	9	9	9	17—9—'29
M 3 w 17—9—9/17	1—7—'29	17	9	9	9	17	17—9—'29
M 4 w 17—9—9	1—7—'29	17	17	9	9	9	17—9—'29
M 17—17—op	1—7—'29	17	17	17	in the open	in the open	17—9—'29
M 17—17—17	1—7—'29	17	17	17	17	17	17—9—'29
M 17—17	1—7—'29	17	17	17	17	17	unplanted
M 21—13—op	1—7—'29	21	21	13	in the open	in the open	17—9—'29
M non—non—op	10—7—'29	non—treatment			in the open	in the open	19—9—'29

the same temperature conditions, after 1st July a division took place. Table I also shows the temperatures applied after the lifting.

The various lots have been named according to their treatment. The first figure after the letter M (= Murillo) indicates the temperature during the pre-treatment. This pre-treatment almost coincides with the period of the formation of the organs. The second figure indicates the temperature of the after-treatment. The third figure refers to the temperature when the bulbs were planted. If the bulbs were planted in the open, the letters op are used. In case it is necessary for the sake of distinction, the duration of the treatment is indicated in weeks e.g. M 3 w 17—9—9. Should the temperature during a period vary, then the initial and final temperatures are stated e.g. M 3 w 17—9—9/17. The lot mentioned last on the table was stored in an unheated room and did not receive any controlled treatment. From 10—20 July the temperature here was near 30° C., from 20—30 July the temperature gradually dropped from 30° C. to 18/19° C. and then kept about 17/18° C. till the planting time.

Reducing sugars.

Table II and fig. 2 show the percentage of reducing sugars of each lot. Till about November the bulbs contained very little of these sugars. After 6th May the concentration diminished rapidly, was almost constant then till 1st July. Then a rise and fall ensued after which finally a continually quicker rising commenced. During the period between lifting and planting, there is a difference between the various lots, which can hardly be attributed to the temperature applied. This is probably due to variability and errors in the determinations.

Also after the planting, one notices little difference at first, but after the middle of December, two groups can be distinguished. The concentration of the bulbs planted at 9° C. and 17° C. increases more considerably than the parcels planted in the open. As the outside temperature was much lower than 9° C. in that period, it is self-evident that the temperature now plays a predominant part. The higher it is, the quicker the reducing-sugars increase. Yet the after-effect of the temperature applied in summer makes itself felt. This is evident from the fact that the sugar percentage of M 3 w 17—9—9/17, the temperature of which had been advanced from 9° C. to 17° C. on the 5th November had already greatly increased on 31st December whereas M 17—17—17 which had also been planted at 17° C. was only able to do so after 1st January. This lot could only then increase at 17° C. its concentration of reducing-sugars more rapidly than the bulbs planted at 9° C.

The preceding treatment in summer and autumn therefore influences the date when the bulb is capable of increasing its percentage of reducing-sugars at a fairly high temperature.

That the planting, as was to be expected, exercises a great influence

TABLE II.

Murillo 1929—1930. Survey of the carbohydrate metabolism in per cents of the dry weight.

Date	Joint treatment			
	Dry W. Fresh	Red. sug.	N-red. sug.	Starch
6— 5—'29	0.266	0.60	20.0	46.7
27— 5—'29	0.316	0.07	3.8	61.9
17— 6—'29	0.396	0.17	7.4	58.6
1— 7—'29	0.424	0.16	5.8	67.6

	M 3 w 17—9—9				M 3 w 17—9—9/17				M 4 w 17—9—9				M 17—17—op				M 17—17—17				M 17—17				M 21—13—op				M non non—op			
	Dry W. Fresh	Red sug.	N-red. sug.	Starch	Dry W. Fresh	Red. sug.	N-red. sug.	Starch	Dry W. Fresh	Red sug.	N-red sug.	Starch	Dry W. Fresh	Red sug.	N-red. sug.	Starch	Dry W. Fresh	Red. sug.	N-red sug.	Starch	Dry W. Fresh	Red sug.	N-red sug.	Starch	Dry W. Fresh	[illegible]	[illegible]	[illegible]	Dry W. Fresh	[illegible]	[illegible]	[illegible]
5— 7—'29	0.445	0.22	6.1	63.9					0.445	0.22	6.1	63.9	0.445	0.21	6.1	64.6									0.445	0.22	6.1	67.0				
10— 7—'29																													0.425	0.22	6.4	64.4
22— 7—'29	0.425	0.37	6.1	66.7					0.425	0.37	6.1	66.7	0.425	0.37	6.1	66.7									0.424	0.50	6.7	64.7				
1— 8—'29	0.428	0.29	6.8	61.3					0.436	0.39	6.4	66.9	0.436	0.39	6.4	66.9									0.421	0.33	5.5	70.1	0.432	0.79	6.6	64.5
19— 8—'29	0.439	0.68	13.4	61.0					0.435	0.47	10.9	65.7	0.444	0.45	7.0	67.8									0.440	0.55	6.2	60.3	0.435	0.51	7.4	67.9
13— 9—'29	0.440	0.27	13.9	59.5					0.454	0.35	14.3	59.9	0.463	0.23	7.0	72.8									0.431	0.74	11.7	67.1	0.446	0.57	8.1	69.4
8—10—'29	0.436	0.18	19.7	50.7					0.428	0.31	17.8	52.0	0.446	0.31	13.8	59.2	0.441	0.16	7.9	65.6	0.463	0.17	8.0	66.7	0.427	0.17	10.0	60.0	0.445	0.22	8.8	69.4
5—11—'29	0.339	0.26	18.6	62.6	0.339	0.26	18.6	62.6	0.423	0.24	16.0	38.5	0.431	0.51	16.7	59.0	0.445	0.32	10.5	70.1	0.500	0.16	10 1	66.8	0.407	0.28	14.4	65.1	0.418	0.41	15.7	62.3
3—12—'29	0.363	0.49	18.8	60.2					0.375	0.43	18.3	—	0.358	0.66	18.2	62.1	0.419	0.30	10.7	72.2	0.494	0.21	9.2	69.6	0.364	0.51	18.1	62.8	0.382	0.70	19.3	55.5
31—12—'29	0.366	0.77	18.3	60.8	0.360	2.81	25.8	55.1	0.325	0.93	20.6	56.2	0.360	0.59	19.6	61.6	0.390	0.24	12.3	62.3	0.494	0.21	9.8	72.2	0.355	0.65	19.6	55.3	0.354	0.86	21.4	52.8
31— 1—'30	0.317	1.64	17.1	56.2					0.332	1.50	17.3	51.3	0.335	1.13	17.6	53.4	0.323	1.53	18.1	63.0	0.510	0.16	10.0	69.1	0.333	0.98	20.1	52.4	0.338	0.66	20.3	50.3
26— 2—'30	0.323	2.15	18.2	50.4					0.305	2.00	17.2	—	0.365	—	—	—	0.319	2.45	21.0	54.1	0.513	0.12	9.9	68.5	0 306	1.42	21.3	47.1	0.296	1.66	25.3	43.1
14— 3—'30	0.269	3.8	21.4	39.7					0.283	3.30	21.8	47.1																				
26— 3—'30																					0.535	0.23	12.8	63.2	0.305	1.30	19.3	51.6	0.320	1.77	21.6	50.6
25— 4—'30																					0.568	0 27	14.7	59.3	0.264	2.30	21.7	55.2	0.274	1.78	21.5	53.9
1— 5—'30																									0.278	3.00	22.4	50.3	0.275	2.70	22.1	52.0
15— 5—'30																									0.217	4.70	21.3	29.0	0.255	4.20	21.0	38.0

too, is apparent from the unplanted M 17—17 bulbs which could not at all increase their concentration.

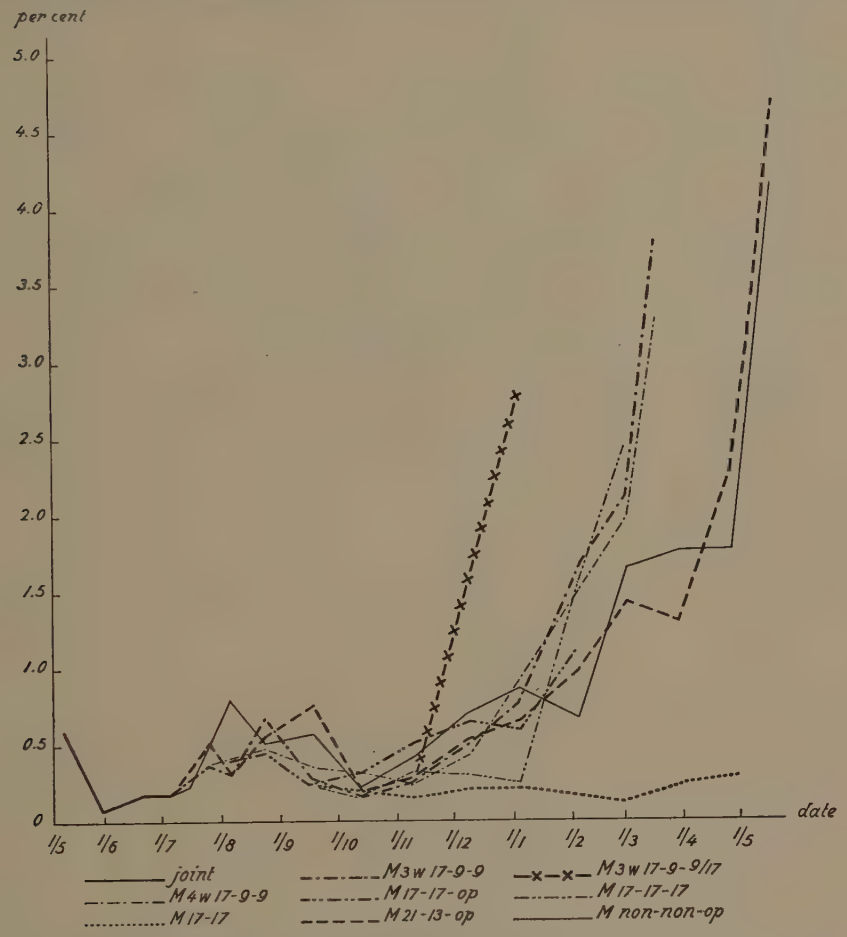

Fig. 2. Murillo. Season 1929—1930. Reducing sugars in per cents of the dry weight.

Non-reducing sugars.

From 6th May until the lifting a great fall takes place (Table II and fig. 3). On discussing the percentage of starch it will appear that this diminishing of concentration is attended with an increase of starch. It is one of the phenomenons of the ripening process of the bulbs by which the sugars formed are stored as reserve food in the form of starch.

After the lifting the reversed process takes place viz; the decomposition of the stored starch. This decomposition or conversion into more useful carbohydrates is greatly dependent on the temperature. As soon as this is decreased, the percentage of non-reducing sugars increases. The lots M 3 w 17—9—9, M 3 w 17—9—9/17, M 4 w 17—9—9 and M 21—13—op already do this before being planted, as soon as they have been put in 9° resp. 13° C. M 17—17—op and M non—non—op immediately after

being planted in the lower outside temperature. M 17—17—17 which was planted at 17° C. increased its concentration much slower. The unplanted

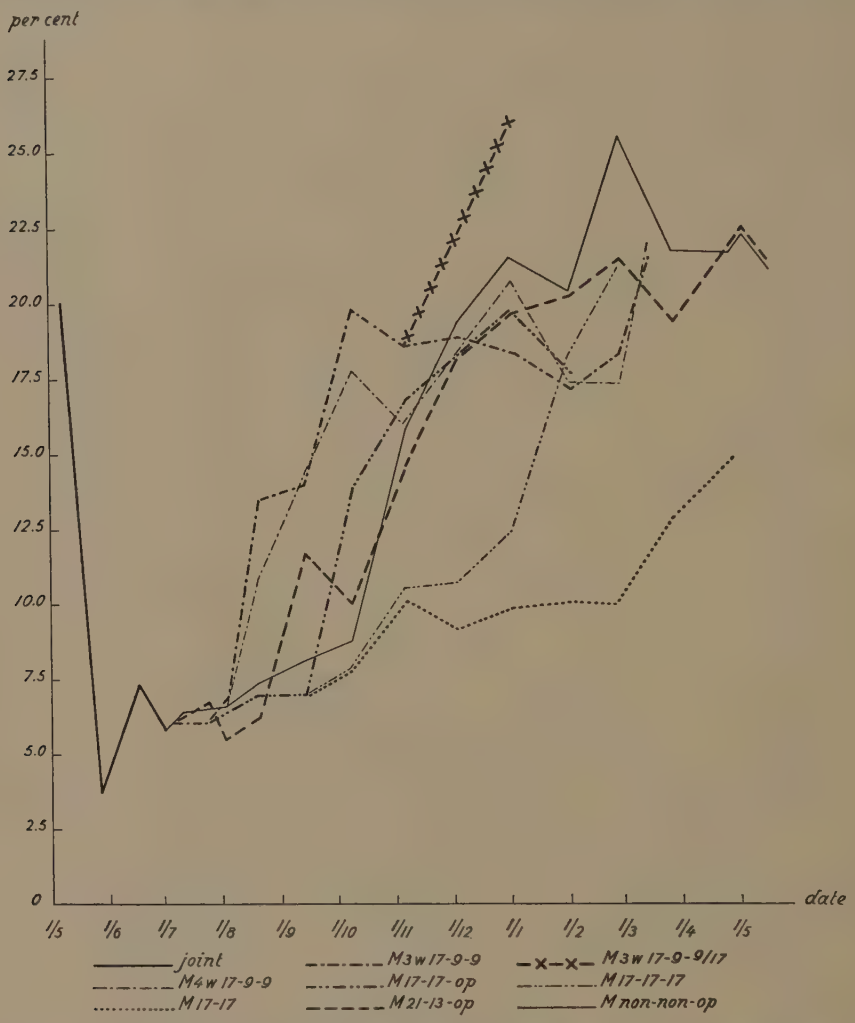

Fig. 3. Murillo. Season 1929—1930. Non-reducing sugars in per cents of the dry weight.

M 17—17 bulbs were still much tardier. Besides the lowering of temperature, the planting therefore also promotes the raising of the concentration.

Early in December the lines of parcels planted at 9° C. and in the open intersected; their concentrations were therefore now almost equal. During the first period after this intersection the concentration at 9° is somewhat lower than in the colder outside temperature; after that the first mentioned parcels again rise to the percentage of the bulbs planted in the open. It is open to doubt whether this difference, as during the summer treatment is really based on the fact that the percentage of

these sugars is lower at a higher temperature, as a comparison between M 3 w 17—9—9 and M 3 w 17—9—9/17 shows us. On 31st December

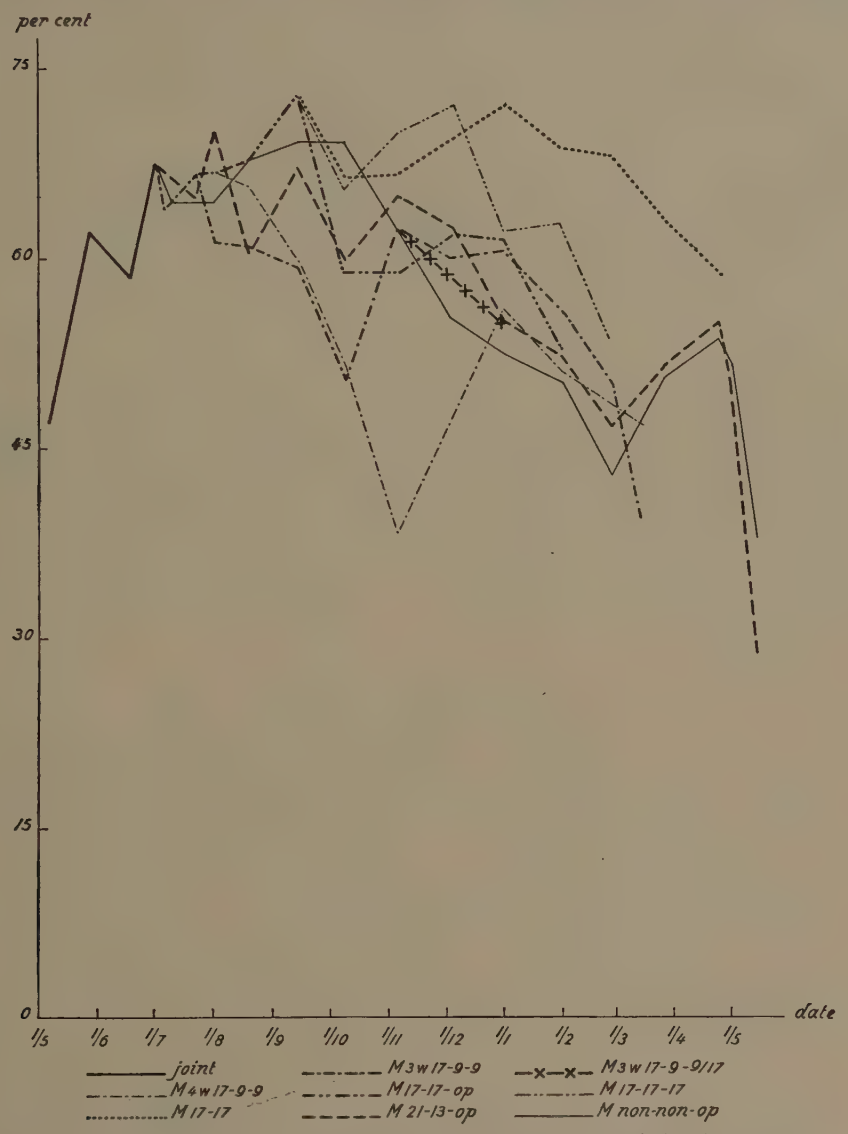

Fig. 4. Murillo. Season 1929—1930. Starch in per cents of the dry weight.

the latter lot contained much more non-reducing sugars than the former lot. If the determination of M 3 w 17—9—9/17 is correct then in this case the higher temperature must have promoted the forming of non-reducing sugars. This contrast will be discussed elsewhere, but already it may be observed that the bulbs planted at 9° C. were in a much further advanced stage on 31st January and 26th February and had a smaller dry weight than the bulbs planted in the open. Both groups are therefore not quite comparable.

It is also of importance that M 3 w 17—9—9/17 notwithstanding its higher concentration at 17° C. showed a much quicker increase than M 17—17—17. A similar rapid increase with M 17—17—17 only appeared after 1st January. In this case too, the temperature applied in summer makes itself felt. The dates at which an advance of the temperature causes an increase of the non-reducing sugars is therefore through previous cooling shifted to an earlier date.

It cannot be explained to what factors this change in behaviour is due. Perhaps the formation of the non-reducing sugars is controlled in summer by a process which elapses quicker at lower temperatures and some time after planting by a process which is more rapid according to the temperature being higher, therefore a changing of the limiting factors.

Starch.

Table II and fig. 4 show the increase of starch before lifting which has already been discussed. The behaviour after lifting principally corresponds to what can be expected from the behaviour of the non-reducing sugars. For instance the percentage of starch is lower on 13 September in proportion to the bulbs containing more non-reducing sugars on that day. In broad outlines the curves for starch and non-reducing sugars are each others reflection.

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(To be continued).

Plantkunde. — *Vergelijking der jonge organen van Spaansche, Engelsche en Hollandsche Irissen.* (with summary). Door A. VAN DER MEULEN en IDA LUYTEN. (Mededeeling N°. 49 van het Laboratorium voor Plantenphysiologisch Onderzoek te Wageningen.)

(Communicated at the meeting of June 27, 1936).

De bedoeling van dit onderzoek was om de periodieke ontwikkeling van den eersten bloemaanleg van de Spaansche en Engelsche Iris te vergelijken met die van de Hollandsche Iris, d.i. van *I. Xiphium* L. var. King of the Blues en van *I. xiphioides* Ehrh. var. King of the Blues met *I. Xiphium praecox* var. Imperator.

BLAAUW [1]) heeft deze ontwikkeling bij Imperator uitvoerig nagegaan; voor de methodiek van dit onderzoek zij daarnaar verwezen.

De hier onderzochte Spaansche en Engelsche irissen werden den 18den Augustus 1933 ontvangen, van elke partij werden direct 10 stuks gefixeerd. De irissen werden in evenveel gelijkwaardige partijen van 10 stuks verdeeld, als er later fixaties plaats vonden. Bij de Spaansche irissen was het gemiddelde gewicht van 10 bollen bij aankomst 63 g, bij de Engelsche irissen was dit 145 g. Alle bollen werden bij 23° C gelegd tot 25 September, dan bij 17° C tot 23 October en vervolgens buiten geplant. Tijdens dit bewaren had de Engelsche Iris erg veel last van luis, als geplante bol rotte hij hierdoor in vele gevallen weg, zoodat er nog al wat uitvallers waren. Bollen, die daarvan geleden hadden, zijn buiten beschouwing gelaten.

Van beide soorten hadden in 1934 op de volgende data fixaties plaats: 2 Januari, 1 Februari, 1 Maart, 29 Maart, 10 April (alleen Spaansche Iris), 17 April (alleen Spaansche Iris, n.l. de 5 grootste uit het restant op het veld) en 26 April (alleen Engelsche Iris, de 7 grootste uit het restant op het veld).

Op blz. 13 e.v. van Med. N°. 43 wordt de samenstelling van den Imperatorbol beschreven; in het algemeen verschilt die van de Spaansche en van de Engelsche Iris hier weinig van. Er zij op gewezen, dat hier planten vergeleken worden, die onder volkomen gelijke omstandigheden gegroeid zijn, aangezien het bekend is, dat b.v. verschillende temperaturen tijdens en voor den aanleg gegeven een grooten invloed kunnen hebben op het aantal gevormde loofbladeren, op de vorming van de spatha-bladeren of van de

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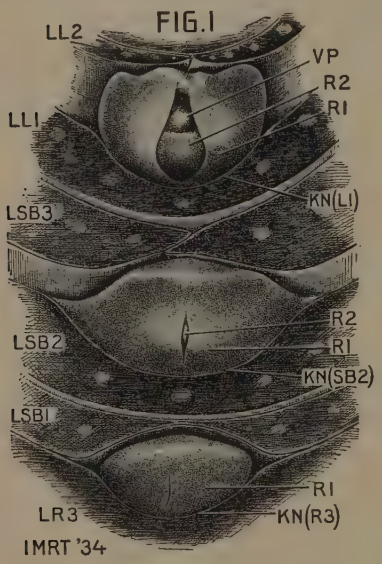
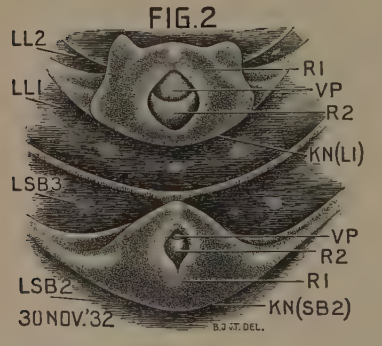
[1]) BLAAUW, A. H. De periodieke ontwikkeling van een bol-iris. Verhandel. Kon. Akad. v. Wetensch. A'dam, Afd. Nat. 2de sect. Dl. **34**, 1935 en Med. **43** v. h. Lab. v. Plantenphysiol. Onderzoek, Wageningen.

tweede bloem, op den vorm van het bloemprimordium enz. De punten van verschil zullen hieronder achtereenvolgens worden besproken.

De bloeibare ronde bol van de Spaansche Iris wordt door 1—3 bruine vliezen omgeven, dit zijn de resten van loofbladeren van het vorige jaar, hierop volgen 3 dikke rokken als bij de Imperator, een heel enkele maal 4 (1 maal op 61 bollen), vervolgens 2 of 3 scheedebladeren, n.l. 1 maal 4, — 35 maal 3 en 25 maal 2, hierbij zijn dan ook de z.g. halve rokken gerekend, alles op vrijwel dezelfde wijze ingeplant en van ongeveer gelijken vorm als bij Imperator. Het totale aantal loofbladeren was in 15 gevallen 6 en even zoovele malen 7.





Vergr. 22 ×.
KN(L1) = knop in 1ste loofblad, etc.
LL = litteeken loofblad; LSB = litteeken scheedeblad; R = rok; VP = vegetatiepunt.

Wat de okselknoppen betreft, deze vertoonen bij de Spaansche Iris (Fig. 1) veel overeenkomst met die van Imperator. Ook hier vindt men in den oksel van het eerste loofblad LL 1 altijd den knop KN (L 1), die den hoofdbol voor het volgende jaar zal vormen. Hij heeft echter *niet dien typischen vorm*, dien deze knop bij I. Imperator (Fig. 2) heeft. Op de plaats, waar deze bij Imperator typische hoorntjes, later slippen, draagt, vindt men hier de twee hoeken afgerond. De knoppen in de scheedebladeren KN (SB), zijn niet in het midden puntig zooals bij Imperator (Fig. 2) maar juist meer plat, eenigszins trapezium-vormig (Fig. 1).

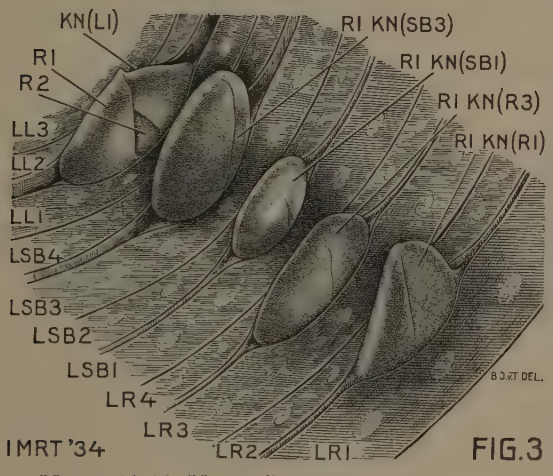
De stadia, waarin men den bloemaanleg kan verdeelen, verschillen ook in 't een en ander van die bij Imperator.

In stadium I is weinig verschil tusschen deze twee irissen, maar het stadium II+ vertoont reeds wat in de latere stadia het groote punt van verschil zal worden, n.l. *het kleinblijven van de tweede bloem*. Men ziet bij Imperator dan reeds duidelijk het zijbloemprimordium ontstaan (BLP in fig. 34 Med. N°. 43), bij de Spaansche Iris is hier nu nog niets van te vinden. Fig. 4 geeft den bloemaanleg van de 1ste bloem en het primordium voor de 2de bloem weer op 29 Maart, de 1ste bloem is in stadium IV. We merken nu, in vergelijking met Imperator (fig. 38 in Med. N°. 43), het nog zeer kleine vegetatiepunt van de 2de bloem op. Verder valt op, dat de afstanden tusschen de meeldraden onderling kleiner zijn en het centrum

dieper ingezonken is dan bij Imperator. In stadium V is het verschil nog sterker geworden, opvallend is nu het kleine 2de bloemprimordium en de geringere afstand tusschen de meeldraden. Ook in stadium VI is het primordium van de 2de bloem nog klein, maar het is wel normaal ontwikkeld.

In de fixatie van 29 Maart werd een zeer eigenaardige abnormaliteit gevonden (Fig. 6). Het tweede spathablad (SPL 2) is 90° gedraaid en heeft een tweede kleine top gevormd tegenover de oorspronkelijke. Ook de 1ste bloem en het 2de bloemprimordium (ZBLP) daarbinnen zijn 90° gedraaid. In de bloem, die in stadium IV— is en als van twee zijden samengedrukt is, staan de 3 tepaal- en meeldraadprimordia (T I en M I) hiermee goed in verband; ze hebben een niet zeer abnormalen vorm; er is echter een vierde tepaal en meeldraad in den buitensten krans bijgekomen. Deze T I is op de teekening niet te zien, het is bedekt door het laatst gevormde loofblad (L 7).

De bloeibare bol van de Engelsche Iris, die hier onderzocht werd was geen ronde bol als van de Spaansche Iris en de Imperator, maar een z.g. „platte bol". Eigenaardig is het, dat de Engelsche Irissen wel algemeen als platte bollen (hoofdbol van een bloeier) geleverd worden. Ook hier bleek weer, dat deze bollen vatbaarder zijn voor infectie dan ronde bollen. Voor de wijze van ontstaan en bouw van de platte bollen in het algemeen zie Blaauw (Med. No. 43).



Vergr. 11 ×. Voor afkortingen zie fig. 1 en 2.

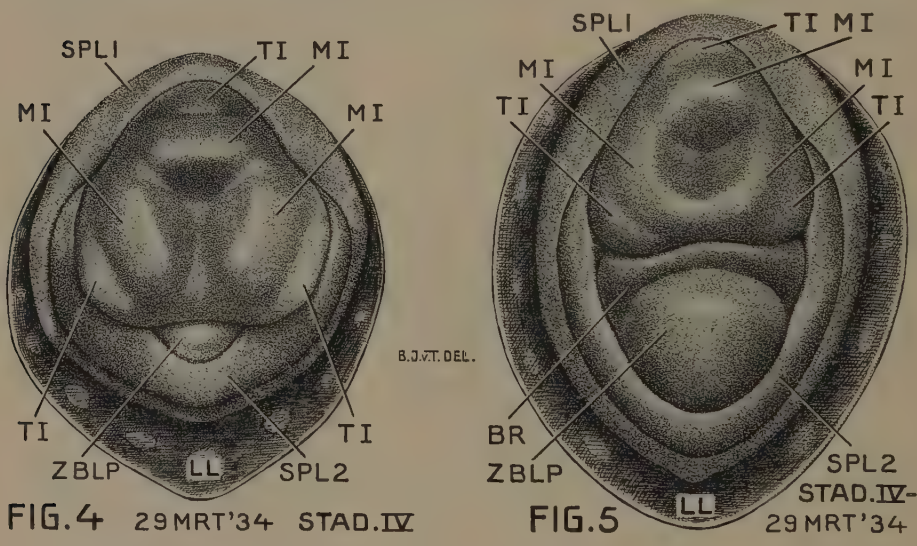
Deze Engelsche irisbollen zijn evenals de platte bollen van Hollandsche irissen door hoogstens 1 bruin vlies omgeven; dit is op te vatten als de eerste rok, die leerachtig is. In zeer vele gevallen is dit vlies ook al verdwenen, hetgeen de kans op beschadiging en infectie vergroot. Een heel enkele keer is er nog iets te zien van een tweede bruine schub, dat dan de rest is van de basis van het loofblad, waarin de bol het vorige jaar aangelegd en gevormd was. Op dit bruine vlies volgen *altijd 4 rokken* in tegenstelling met de Spaansche Iris en I. Imperator, die er 3 maken. Vervolgens vindt men de scheedebladeren, meest 3 of 4 in getal, n.l. 1 keer 2, — 14 keer 3, — 32 keer 4 en 1 keer 5, hier zijn de halve rokken ook bij inbegrepen. Het aantal loofbladeren was in 1 geval 6, — 2 keer 7, — 15 keer 8 en 2 keer 9. De loofbladeren hebben jong reeds een zeer opvallend, door de nerven geribd uiterlijk; ze zijn hierdoor, in tegenstelling met de Spaansche Iris en de Imperator reeds vroeg *gemakkelijk van de scheedebladeren te onderscheiden.*

De okselknoppen van de Engelsche Iris (Fig. 3) zijn ook geheel anders

dan die van de beide andere irissoorten. De knop in den oksel van het eerste loofblad (KN L 1) komt *lang niet altijd tot ontwikkeling*: slechts in 24 van de 34 bollen); ze hebben ook *niet den typischen vorm* van die knoppen bij Imperator. Van de grootste breedte, die ongeveer op $^1/_3$ van de hoogte ligt, loopt de knop spits toe naar den top, die meest met een eigenaardig puntje eindigt. Welke knop den hoofdbol voor het volgende jaar zal vormen, indien de knop in het eerste loofblad niet aanwezig is, was niet met zekerheid uit te maken.

Opvallend groot in vergelijking met Imperator zijn de knoppen in de scheedebladeren KN (SB) en in de rokken KN (R). Van een typeerenden vorm is hier niet veel te bespeuren, de knoppen in de éérste scheedebladeren zijn wat korter en breeder dan die in de meer naar binnen gelegene. Bij de knoppen in de oksels van de rokken is het juist andersom, hier vinden we de grootste knoppen meestal in rok 2 en 3, de kleinere in rok 4.

Bij de bollen op 26 April gefixeerd, bleken de knoppen in de scheede-



Spaansche Iris. Engelsche Iris.

Vergr. 53 ×. BR = bractee; LL = litteeken loofblad; MI = meeldraad 1ste krans; SPL = spathablad; TI = Tepaal 1ste krans; ZBLP = zijbloem-primordium.

bladeren en de buitenste rokken dikwijls abnormaal lang geworden te zijn, éénmaal b.v. was de knop in den oksel van het 2de scheedeblad 4 cm. Zulke knoppen worden dit jaar dan niet tot bolletjes, die het volgende jaar pas bladeren laten uitloopen, zooals normaal is, maar ze zijn hun ontwikkeling klaarblijkelijk een jaar vooruit. *Reeds dit jaar vormen ze blad en assimileeren ze;* ze leveren een grooteren bol dan wanneer ze niet uitgeloopen waren. Op 1 en 29 Maart is dit dikwijls al te zien bij de knoppen in de rokken.

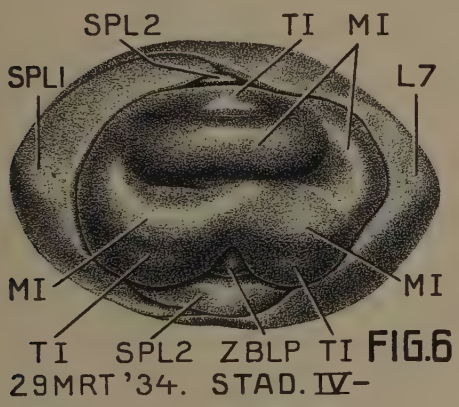
De samenstelling en de grootte van den hoofdknop van de bloeibare Spaansche en Engelsche Iris werd nagegaan bij de op 29 Maart 1934

gefixeerde bollen; dit ter vergelijking met de Iris Imperator (BLAAUW, blz. 60 e.v.). Bij de Spaansche Iris was de gemiddelde lengte 2.04 mm (8 bollen), het aantal afsplitsingen 7 maal 4 en 1 maal 5. Bij de Engelsche Iris was slechts in 4 van de 8 gevallen het vegetatiepunt in den oksel van het eerste loofblad uitgegroeid, de gemiddelde lengte van deze 4 knoppen was 1.82 mm, 3 maal waren hierin 5 en 1 maal 6 afsplitsingen zichtbaar.

In vergelijking met de Spaansche Iris heeft de Engelsche meer punten van verschil met de Iris Imperator bij de onderscheiding van de stadia, die het jonge bloemprimordium bij zijn ontwikkeling doorloopt. Bleef bij de Spaansche Iris de tweede bloem in vergelijking met die van de Imperator klein, bij de Engelsche Iris *ontwikkelt deze zich*, onder voor al deze drie Irissoorten gelijke omstandigheden, juist *bijzonder sterk*.

Reeds in stadium II ziet men opvallend duidelijk het zijbloemprimordium komen. In stadium III zijn deze twee bloemprimordia bijna gelijkwaardig, het zijbloemprimordium is even hoog als het vegetatiepunt van de eerste bloem, maar iets kleiner.

Fig. 5 geeft de ontwikkeling van het primordium, als de eerste bloem in stadium IV— is. Vergelijkt men dit met fig. 38 uit Med. N°. 43 en fig. 4 in dit artikel, dan valt direct het groote 2de bloemprimordium (ZBLP) op met zijn, in dit stadium, reeds geheel afgesplitste bractee (BR).



Vergr. 53 ×. Voor afkortingen zie fig. 4 en 5.

Bij de eerste bloem vormen in tegenstelling met Imperator de drie meeldraadprimordia (M I) nu nog een rondloopenden wal. Het centrum geeft wel reeds duidelijk de 3 primordia aan. Stadium V en VI verschillen, afgezien van de grootte van de tweede bloem, weinig van de Spaansche Iris en van Imperator.

Dat de Iris Imperator in de hierboven genoemde punten een grootere overeenkomst vertoont met de Spaansche dan met de Engelsche Iris, is begrijpelijk door de nauwe verwantschap van Iris Imperator met de vroege Spaansche Iris; terwijl de Engelsche Iris, hoe na ook verwant als soort, toch niet heeft bijgedragen tot de vorming van Imperator en van de Hollandsche irissen in 't algemeen.

We zullen nu nog, kort samengevat, de ontwikkeling van de loofbladen nagaan en *de tijden van den bloemaanleg vergelijken*.

Op den datum van aankomst (18 Aug.) had het eerste loofblad (9 bollen) van de *Spaansche Iris* een gemiddelde lengte van 1.65 mm. Alle bollen zijn nog in het bladafsplitsende stadium en hebben 4 à 5 loofbladeren, n.l. 3 maal 4 en 6 maal 5. In dezen tijd is het 1ste loofblad van de scheede-

bladeren te onderscheiden doordat het in tegenstelling met deze niet geheel gesloten is.

Bij de Engelsche Iris heeft op 18 Aug. het 1ste loofblad een gemiddelde lengte van 2.7 mm. Ook deze bollen zijn nog in het bladafsplitsende stadium: er zijn 3 maal 6, — 5 maal 7 en 2 maal 8 loofbladeren.

TABEL 1. Gemiddelde lengte van het 1ste loofblad in cm en gemiddelde van het aantal loofbladen.

Datum	Spaansche Iris			Engelsche Iris		
	Aantal bollen	Lengte 1ste loofblad	Aantal loofbl.	Aantal bollen	Lengte 1ste loofblad	Aantal loofbl.
18 Aug. '33	9	0.165	4.8	10	0.27	5.3
2 Jan. '34	10	3.12		5	1.37	8.0
1 Febr. '34	9	6.2		7	2.05	8.0
1 Mrt. '34	10	11.1	6.8	7	3.90	8.0
29 Mrt. '34	9	21.6	6.4	7	7.70	7.8
10 April '34	7	30.4	6.1	—		
17 April '34	5	37.9	6.6	—		
20 April '34				7	24.20	8.0

Uit tabel 1 lezen we af, dat de Spaansche Iris gemiddeld 6—7 loofbladen vormt, terwijl de Engelsche Iris vrij regelmatig 8 loofbladeren aanlegt. Indien men dus bij deze laatste bij fixaties van jongeren datum een 9de afsplitsing opmerkt, die men dan nog niet als spathablad kan onderscheiden, kan men deze toch met vrij groote zekerheid als 1ste spathablad aanduiden.

Verder merken we aan de strekking der loofbladen in den winter reeds duidelijk, dat de Spaansche Iris de Engelsche voor is en het eerst zal bloeien. Deze bloeidata vindt men in tabel 2 aangegeven.

Vergelijken we in tabel 2 de tijden van bloemaanleg van de Spaansche en Engelsche Iris met die van Imperator (overgenomen uit BLAAUW 1935, blz. 49), dan zien we dat er niet veel verschil is, maar toch merken we op dat de aanleg van de Spaansche Iris iets later is dan die van Iris Imperator en dat de vorming van de bloem van de Engelsche weer iets achter de Spaansche aankomt. Wij zien dit verschil het beste, wanneer we naar de data van het 1ste begin kijken n.l. 1 Febr. De nuance die er dan te vinden is, blijft ook in de volgende data aanwezig.

In 't begin wezen wij er reeds op, dat verschillende temperaturen vóór en tijdens den aanleg grooten invloed kunnen oefenen, ook op den tijd van bloemaanleg. Bij Iris Imperator was daarom reeds ter contrôle deze

TABEL 2. Het voortschrijden van den aanleg van spathabladeren en bloemdeelen (in stadia verdeeld).

Datum van fixatie	Aantal bollen	Aantal met SPL1	Aantal met SPL2	*Iris Imperator* I	I+	Ia/II	II−	II	II+	IIa/III	III−	III	III+	IIIa/IV	IV−	IV	IV+	IV à V	V−	V	V+	Va/VI	VI−	VI
1 Dec. '33	15	2	—																					
2 Jan. '34	10	8	2	10	—	—	—																	
1 Febr. '34	9	9	9	—	—	5	3	—	1	—	—													
1 Mrt. '34	10	10	10	—	1	—	—	1	—	1	3	3	1	—	—									
16 Mrt. '34	9	—	—									—	—	2	5	2	—	—	—					
29 Mrt. '34	9	—	—									(1)				—	—	—	1	7	—	—	—	
10 April '34	10																		—	—	—	—	10	—

Begin bloei eind Mei 1934

Spaansche Iris

18 Aug. '33	9	—	—																					
2 Jan. '34	10	?	—	10	—	—	—																	
1 Febr. '34	9	?	6?	2	4	1	1	1	—	—	—													
1 Mrt. '34	9	9	7?	—	—	3	2	2	2	—	—													
29 Mrt. '34	9	—	—									—	—	—	1	2	—	1	3	2	—	—	—	
10 April '34	7	—	—																	—	—	1	6	
17 April '34	5	—	—																	—	—	—	—	5

Begin bloei 6 Juni 1934

Engelsche Iris

18 Aug. '33	10	—	—																					
2 Jan. '34	6	1	1	6	—	—	—																	
1 Febr. '34	7	4	1	6	—	1	—																	
1 Mrt. '34	7	7	7	—	—	—	—	1	1	1	3	1	—	—	—									
29 Mrt. '34	5	—	—									—	—	—	2	—	—	—	—	2	1	—	—	
26 April '34	7															—	—	—	1	1	—	1	1	3

Begin bloei 16 Juni 1934

aanleg in 2 opeenvolgende jaren 1932—1933 en 1933—1934 vastgesteld (blz. 47—50).

Over het algemeen kon men uit die gegevens afleiden, dat in genoemde

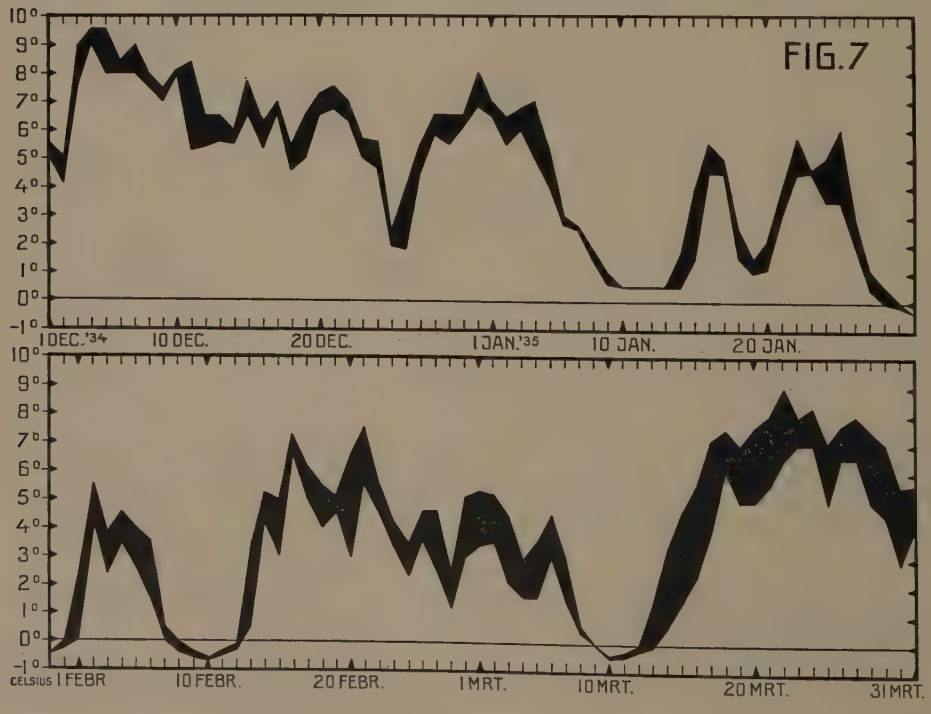
jaren die tijden elkaar weinig ontliepen en de bloemaanleg in hoofdzaak in Maart plaats had. Toch ziet men aldaar in Tab. 5 dat in 1934 zelfs op 1 Febr. een begin van den bloemaanleg zichtbaar is, dat op 1 Maart deze nog iets vóór is bij 1933, terwijl half Maart de bloemaanleg van 1933 dien van 1934 heeft ingehaald.

In 1935 bemerkten we echter, dat de tijd van eersten bloemaanleg vrij wat anders was uitgevallen niettegenstaande dezelfde voorbehandeling toegepast was. Het blijkt (zie tab. 3), dat op 1 Febr. de bloemaanleg in 1935 reeds in vollen gang is. Gemiddeld genomen is stadium IV reeds bereikt.

TABEL 3. Het voortschrijden van den aanleg van bloemdeelen (in stadia verdeeld) bij Iris Imperator in 1935 te Wageningen.

Datum 1935	Aantal	I	II	III	III+	III à IV	IV⁻	IV	IV+	IV à V	V⁻	V	V+	V à VI	VI⁻	VI
1 Febr.	12			1	—	—	3	3	2	3	—					
15 Febr.	6							—	—	2	—	4	—	—	—	
1 Mrt	6											1	—	4	1	
16 Mrt	5											—	—	1	2	2
30 Mrt	5															5

Dit werd in 1933 pas tegen half Maart, in 1934 ruim 16 Maart bereikt. Ook hier is, evenals bij BLAAUW 1935, een grafiek (Fig. 7) toegevoegd van



de temperatuurszône, in den grond op 10 cm diepte opgenomen, waarbinnen de bloemaanleg moet hebben plaats gehad.

Uit de grafiek volgt, dat o.a. de temperatuur in December '34 veel hooger was dan in de twee voorafgaande jaren.

Dit zou er een aanwijzing voor kunnen zijn, dat de tijd van den bloemaanleg bij deze irissen niet zoo constant is, als uit de resultaten van de fixaties in 1932—1933 en 1933—1934 wel zou kunnen volgen, maar meer afhankelijk is van uitwendige invloeden.

Om dit te onderzoeken fixeerden wij in 1936 nog eens planten, in Haamstede (Z.) gegroeid, terwijl ter vergelijking later ook nog bollen van Heemskerkerduin (N.-H.) werden onderzocht.

TABEL 4. Het voortschrijden van den aanleg der bloemdeelen bij I. Imperator in 1936 in Zeeland en Noord-Holland.

Datum	Aantal	Gemidd. omtrek in cm.	Aantal loofbl.	Stadia												
				III	III+	III à IV	IV⁻	IV	IV+	IV à V	V⁻	V	V+	V à VI	VI⁻	VI
Haamstede (Z.)																
15 Febr.	9	7.2	7×7 2×8	—	—	—	1	1	—	3	1	3	—	—	—	—
27 Febr.	6	7.1	4×7 2×8	—	—	—	—	—	—	—	1	5	—	—	—	—
14 Mrt	9	7.2	4×7 5×8	—	—	—	—	—	—	—	—	—	1	4	4	—
27 Mrt	17	7.5	6×7 11×8	—	—	—	—	—	—	—	—	—	—	1	16	—
Heemskerkerduin (N. H.)																
2 Mrt	12	7.3	7×7 5×8	—	—	—	3	2	2	3	2	—	—	—	—	—
13 Mrt	12	7.1	11×7 1×8	—	—	—	—	1	1	1	—	9	—	—	—	—
27 Mrt	11	7.2	10×7 1×8	—	—	—	—	—	—	—	—	1	1	1	8	—

Hieruit blijkt, (tabel 4) dat de Zeeuwsche irissen vóór waren bij de Noord-Hollandsche en ook, dat ze beiden veel voorlijker waren dan de bollen in 1932—1933 en 1933—1934 in Wageningen gegroeid. Echter zijn die van Heemskerkerduin op 2 Maart 1936 nauwelijks verder dan die van Wageningen op 1 Febr. 1935 (zie tab. 3).

De voorbehandeling en de tijd van planting van de beide door de praktijk behandelde groepen bollen van 1936 zullen waarschijnlijk weinig verschild hebben. Dan blijven echter nog klimaats-, standplaats- en

bodeminvloeden, die het verschil in 1936 in den tijd van bloemaanleg bij deze irissen van 2 groeiplaatsen kunnen hebben veroorzaakt. Bij vergelijking met de te Wageningen gegroeide van '33, '34 en '35, moet in aanmerking worden genomen, dat wij behandelden met 23° C tot ± 10 Sept. en daarna 17° C, waarbij 23° C sterk remmend werkt, terwijl over 't algemeen de kweeker deze irissen zoo koel mogelijk laat liggen, d.i. ± 17 à 20° na het rooien. Wel moeten we constateeren, dat de vruchtbladprimordia, die altijd langer op zich doen wachten, ten slotte in alle jaren pas in de 2de helft van Maart, meestal einde Maart, tot stand komen (Stad. VI— of VI).

Vinden we dus voor 1936 tusschen 2 standplaatsen in ons land een verschil van ruim 2, waarschijnlijk 3 weken, — belangrijker is het nu te weten, dat de bloemaanleg van Iris Imperator, soms pas ± 1 Maart begint, maar ook wel op 1 Febr. reeds in gang kan zijn, zoodat die eerste aanleg dan dus in Januari al begonnen is. De bloemaanleg, die toch al bij zeer lage temperaturen in den bodem plaats vindt, verdraagt ook herhaalde dalingen beneden het vriespunt (zie Fig. 7; tegen 1 Febr., 8—12 Febr., en 9—12 Maart). Een aanvankelijk vroeg begonnen aanleg, wordt aldus telkens weer geremd; bij Imperator echter zonder schade voor de bloem.

Wageningen, Mei 1936.

COMPARISON OF THE YOUNG ORGANS OF SPANISH, ENGLISH AND DUTCH IRISES.

The flowering-sized, round bulb of the Spanish iris consists of 1—3 brown membranes, 3, occasionally 4 thick scales, 2—3 sheathing leaves, 6 or 7 foliage leaves. The bud in the axil of the first foliage leaf (Fig. 1 KN (L 1)) has not got that typical shape found in Iris Imperator (Fig. 2), while the buds in the sheathing leaves are not so pointed in the centre but on the contrary flatter, slightly trapezium-shaped (Fig. 1, KN (SB)). From the stages into which the flower-formation may be divided it appears that the side-flower primordium of the Spanish iris remains small. Compare fig. 4 with fig. 38 of communication 43. The distances between the stamens are also somewhat smaller and the centre is deeper. Likewise in stage VI the primordium of the 2nd flower is still small. Fig. 6 reproduces an abnormity. The 2nd spathe leaf SPL 2 has two tops and is turned 90°. The first flower also and the 2nd flower primordium inside are turned 90°. A 4th tepal (T 1) and staminal primordium (MI) have been formed in the outer whorl.

The flowering-sized English bulb was a flat bulb, i.e. the main bulb of a flowerer. The bulb consisted of one brown skin, 4 scales, 3 or 4 sheathing leaves and on an average 8 foliage leaves. With the axillar buds (Fig. 3) we see that the bud in the first foliage leaf does not always reach development; it has besides not that typical shape of the bud of Imperator. The buds in the sheathing leaves (KN SB) are conspicuously large. Frequently they bud yet in the same year, assimilate and thus produce a larger bulb than normally would have been the case.

The young flower-primordium of the English iris displays a strong development of the 2nd flower. Fig. 5 represents stage IV. Besides the large 2nd flower primordium (ZBLP), it is striking that in the first flower, contrary to Imperator, the 3 staminal primordia (MI) form a circular mound. The centre clearly indicates the primordia. Apart from the size of the 2nd flower, the stages V and VI differ little from the Spanish and the Dutch iris.

On the day of arrival (Aug. 18th) the Spanish iris had formed 4 or 5 foliage leaves, the English one averagely 7—8. In the course of months (Table 1, 4th and 7th column) we see that the Spanish iris has formed 6 or 7 foliage leaves and the English one 8. Further we clearly observe from the stretching of the foliage leaves already in winter that the Spanish iris (Table 1, 3rd column) is in advance of the English one (Table 1, 6th column) and will blossom first. These flowering-dates are found in table 2. In table 2 the dates of flower-formation, divided into stages, of the 3 irises may be compared. The formation of the Spanish iris is somewhat later than that of Imperator, the flower-formation of the English iris is a little after that date. We can best observe this difference if we look at the dates of the first beginning, viz. Febr. 1st. The variations then found remain on the successive dates.

Of Iris Imperator the dates of flower-formation of 1933, '34, '35 and '36 were compared. 1933 and '34 hardly deviate from each other (47—50, communication 43). In 1935 (Table 3), in spite of the fact that the same preparatory treatment has been applied, the flower-formation is already in full progress on Febr. 1st (Stage IV). In 1933 this was not attained till the middle of March, in '34 after March 16th. Here also, as in comm. 43, a graphic (fig. 7) has been made of the temperature zone in the ground 10 cm deep. The temperature in December '34 is much higher than in the two preceding years. In order to study these external influences, bulbs from Heemskerkerduin (N.-Holland) and Haamstede (Zeeland) were compared. Those from Zeeland are more than 2, probably 3 weeks ahead of those of N.-Holland (Table 4) and both of them are much earlier than those grown at Wageningen in 1933 and 1934, but Heemskerkerduin is hardly in advance of those of Wageningen on Febr. 1st '35. In all probability the influence of climate, position and soil will have caused the difference in 1936 in the date of flower-formation of irises from 2 growing-places. It is further of importance to know that the flower-formation of Iris Imperator sometimes does not start before March 1st but also may be in progress already on Febr. 1st, so that the first formation then has begun in January. The flower-formation tolerates a repeated fall of temperature below freezing-point. Consequently a flower-formation once started is again and again retarded. In the case of Imperator, however, this does not do any harm to the flower.

Geology. — *The occurrence of isolated calicular plates of Dinocrinus in the Permocarboniferous of Australia and India and its stratigraphical significance.* By H. GERTH. (Communicated by Prof. H. A. BROUWER.)

(Communicated at the meeting of June 27, 1936).

By the investigation of the sponges from the Permian of Timor (7) my attention was drawn to fossils described by ETHERIDGE (5) from the Upper Carboniferous of Western Australia as Calceolispongia Hindei nov. gen. nov. spec. ETHERIDGE's figures reminded me of certain very peculiarly formed calicular plates of Crinoids, described by WANNER from the Permian of Timor. A more accurate comparison of the reproductions of Calceolispongia (fig. 1) with those of the basal plates of Dinocrinus cornutus of WANNER (figs. 2, 3) and especially the study of ETHERIDGE's description made this supposition to certainty. The figures of ETHERIDGE clearly show that Calceolispongia is provided with facets at the outer edge of the "cloaca", the shallow paragaster of the supposed sponge. Such

facets, however, would be perfectly superfluous at the upper edge of a sponge, and indeed it concerns here the facets by which the polygonal

Fig. 1. Three specimens of Calceolispongia Hindei ETHERIDGE fil. in different positions, according to ETHERIDGE (5) pl. IV, figs. 1—8.

Fig. 2. Dinocrinus cornutus WANN. Basal plate of the calyx in three different positions. After WANNER (14) 1916, Pl. XCVII, fig. 11 *a—c*.

Fig. 3. Dinocrinus cornutus WANN. Three different basal plates according to WANNER (15) 1921, Pl. XV, figs. 6—8.

basal plates of the Crinoid calyx have been connected and the supposed "cloaca" is nothing but the slightly hollowed inside of the calicular plate. The ornamentation with small papillose eminences on the convex side of the rounded horn-shaped objects likewise pleads against the sponge nature. ETHERIDGE has to admit that on his "sponges" he could observe neither pores nor ostia, but the microstructure seemed convincing to him. However, of the two reproductions given of this, the one, probably owing to recrystallization of the specimen, is altogether indistinct, while the other clearly shows a structure of meshes, as is characteristic of skeleton parts of echinoderms; only it is particularly strongly magnified [1]) (5, pl. 7, figs. 5, 6).

[1]) ETHERIDGE unfortunately only states: highly magnified.

Form and ornamentation of the objects, the presence of facets on the outside and the microstructure consequently give the certainty that Calceolispongia Hindei is not a sponge but a calicular plate of the Crinoid genus Dinocrinus WANNER, thus far only known from the Permian of Timor. It is much more difficult to ascertain whether the fragments from Australia belong to the species Dinocrinus cornutus WANN. described from Timor, to which, among the three Dinocrinus species known to day, they show the greatest similarity. It is true that most of the Australian pieces on the one side display the same ornamentation with small eminences as the basal plates of Dinocrinus cornutus WANN. but the form is somewhat different. The former are slightly broader at the end and "there is a slight tendency to become belobed in some examples", whereas the lump on the plates of Dinocrinus cornutus from Timor rather has a rounded tapering form. The basal plates of this species, however, also vary somewhat in form, as is shown by WANNER's reproductions (fig. 2 and fig. 3), some pieces likewise having a broader end. In the Australian fragments also a certain variation in the ornamentation occurs, owing to the fact that in one specimen the eminences are replaced by irregular folds. It can, of course, not be decided with certainty whether the above-mentioned differences between the specimens of Australia and those of Timor fall under the variation-range which may occur in the form and decoration of the calicular plates of the same species, the less so as also of Dinocrinus cornutus WANN. only isolated basal plates of the calyx have been found. But Dinocrinus mammeatus WANN., two calyces of which have been described by WANNER (15, pl. 14, figs. 14, 15), shows that the basal plates, not ornamented in this species but also protruding in lump-shape, already vary in form in one and the same individual. The basal plates of Dinocrinus, described as Calceolispongia from Western Australia, may therefore, if we do not want to unite them with Dinocrinus cornutus WANN. itself, at most be distinguished as a variety of this species. As to the nomenclature, here once more the regrettable case is found that a well chosen and characteristic name of the genus Dinocrinus WANNER 1916 according to the law of priority would have to be replaced by Calceolispongia ETHERIDGE 1914, a name entirely misleading for a Crinoid.

In India also isolated plates of Dinocrinus or of related genus appear to occur, viz. in the "Umaria beds" in Rewah State, Central India. These marine beds are found at the basis of sandstones of the Barakar series, which contains a typical Lower Gondwana flora. Among the fossils from these beds described by COWPER REED (1), I was struck by some which he considered "dermal tubercles of fish" (fig. 4). They are polygonal or, probably by weathering, rounded plates of c. 8 mm diameter, tapering at the upper edge to a horn-shaped, curved protuberance. Here also the surface of these protuberances is ornamented with small grains. The presence of facets on the edge of the better preserved plates, showing a similar arrangement as those on the plates of Dinocrinus, led me to suppose

that in this case also we have to deal with isolated calicular plates of Crinoids and not with tubercles of fish. Perfect certainty, however, will

Fig. 4. Three different specimens of "dermal tubercle of fish". After Cowper Reed (1) Pl. 35, figs. 14—16 and 18.

only be obtained by the investigation of the microstructure of one of the fragments from the Umaria beds. With the species of Dinocrinus described from Timor these cannot be united; in Dinocrinus aculeatus WANN. of Timor the basal plates indeed also possess pointed protuberances but these are straight and not curved in horn-shape. In any case, however, we have to deal here with a new species of Dinocrinus or with a closely related genus.

I am inclined to think that the occurrence of the calicular plates of Dinocrinus has a certain stratigraphical significance, particularly where the occurrence in Western Australia is concerned. As we have seen, we have to do here with a form which in all probability is identical with Dinocrinus cornutus WANN. from Timor. However, thus far it has always been apparent that such highly specialized forms as the Dinocrinus species with their peculiarly shaped basal plates live for a comparatively short time. If consequently Dinocrinus cornutus WANN. is found on Timor in the Permian, viz. in the Lower Permian Bitauni beds, it seems fairly certain that also the beds in Western Australia in which it occurs are Permian and not Carboniferous, as was still recently stated by the Australian geologists. That Dinocrinus cornutus WANN. is indeed a species of relatively limited lifetime is also apparent from the fact that on Timor it occurs only in the Lower Permian Bitauni beds. Lately an enormously large material of fossils from the Middle Permian Basleo beds was sifted in the Geological Institute of Amsterdam, but among the many thousands of Crinoids from these beds not a single basal plate of Dinocrinus cornutus was found.

The occurrence of Dinocrinus cornutus WANN. consequently pleads in favour of the Lower Permian age of the late Palaeozoic marine beds in Western Australia. This age was, moreover, recently also proved by the results of other investigations. A. K. MILLER (9) made an elaborate study of Paralegoceras jacksoni (ETHER.), the only Cephalopod in these beds, and was able to point out that this goniatite differs from Carboniferous Paralegoceras species and has to be classified with the Permian genus Metalegoceras. Particularly in the characteristic umbilical region its sutural line displays a pronounced similarity to Metalegoceras somoholense (HANIEL.) from the Lower Permian of Timor, which very likely is merely a juvenile specimen of Metalegoceras evolutum HAN. Further

K. L. PRENDERGAST (10) has recently revised the determination of various Brachiopoda from the above-mentioned beds and has shown that only a few species are not known from the Permian but that most of them have their main extension in this formation. It can, therefore, no longer be doubted that the beds in which these fossils occur are of Lower Permian and not of Upper Carboniferous age, as was stated by DAVID and SÜSSMILCH (2).

The determination of the age of these beds is of great importance because they follow in normal succession above the glacial deposits and in this way we can also obtain a determination of the age of the Upper Palaeozoic glaciation. Western Australia is the only part of the Gondwana region where the marine beds connected with the glacial deposits have yielded a Cephalopod, the above-mentioned Metalegoceras jacksoni ETHER., which admits a determination of the age and further parallelization of these beds. As we have seen, this goniatite is closely related to a species from the Bitauni beds of Timor which, according to WANNER (16), by means of their cephalopod fauna may be parallelized with the Upper Artinskian beds, the lower part of the Sosio limestone and the Leonard formation in Texas. It is true, also in other regions above the glacial deposits marine beds are found, but thus far these have only yielded indifferent faunas, in which the Brachiopoda prevail, and a decisive determination of their age is not possible. They are particularly frequent in S. E. Australia in New South Wales (Lower marine series). Indeed in these beds also the occurrence of a goniatite, Agathiceras micromphalum, was recorded, but according to later researches (13 p. 5) this appeared to be a Bellerophon. Similarly about the age of the Lower Productus-limestone in the Salt Range and the Bareal beds in Argentina the opinions of the investigators even recently differed greatly. DUNBAR (4), however, who subjected the Fusulinae of the former formation to a revision, came to the conclusion that these rather show a Permian than a Carboniferous character, and indeed the Lower Productus-limestone is now placed in the Permian by FOX (6) of the Geological Survey of India. Nevertheless, all investigators agree that these beds, which all show the same connection with the underlying glacial deposits, must approximately be of the same age. The Eurydesma conularia fauna occurring on a slightly lower level in some regions is left out of consideration here, since it is equally useless for a parallelization of the age. However, if now the Permian age of the marine beds in Western Australia is proved, it is evident that also the other above-mentioned marine beds, showing a similar connection with the glacial deposits, likewise must be of Permian age. Indeed a Lower Permian age has lately been suggested by DAVID and SÜSSMILCH (3), while a Middle Permian age, as pleaded by SCHUCHERT (11, 12) cannot be taken into consideration because the genus Metalegoceras is no longer present in the Middle Permian Basleo beds. If, however, as we have seen, the marine beds are of Lower Permian age, I do not see an objection to place the underlying glacial deposits at the basis of the Permian. The

geologists (8) who have always spoken of a Permian ice-age will thus be proved to be in the right. The supposed glacial horizons in the Carboniferous Kuttung series in S. E. Australia are left out of consideration here.

SUMMARY.

The fossils described by ETHERIDGE from the late Palaeozoic beds of Western Australia as Calceolispongia Hindei ETHER. are no sponges but isolated calicular plates of a Crinoid, belonging to the genus Dinocrinus from the Permian of Timor, very likely even to the species Dinocrinus cornutus WANNER from the Lower Permian Bitauni beds of this island. Likewise the fossils from the late Palaeozoic Umaria beds in India, supposed to be tubercles of a fish, evidently are skeleton plates of Dinocrinus or a genus related to this. The occurrence of Dinocrinus cornutus WANN. in Western Australia is considered a new proof of the Lower Permian age of the marine beds which, owing to their connection with the underlying glacial deposits, also admit a conclusion concerning the age of the late Palaeozoic ice-age.

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Anatomy. — *Brain-Bodyweight relation in human ontogenesis.* By J. ARIËNS KAPPERS. (Communicated by C. U. ARIËNS KAPPERS.)

(Communicated at the meeting of June 27, 1936).

Data concerning brainweight in fetal life are rare and the number of data from one author is far too small to be used for our purpose. The softness of the fetal brain makes it difficult to obtain fresh specimens, while preserved material can be used only as far as its weight is concerned with the greatest precaution.

The most reliable data, also on account of their number, are those mentioned in the series collected by JACKSON [1]). Of about 800 male and female specimens of various stages of fetal life published by WELCKER and BRANDT, LEGOU, FAUCON, ARNOVLJEVIC, ANDERSON, BOYD, LOMER, MEEH, LIMAN, THOMA, OPPENHEIMER, MÜHLMANN, COLLIN and LUCIEN, BENEKE and some by himself, JACKSON made a sharp selection, using for brainweight only 316 specimens from the second intra-uterine month to birth.

In his tables he gives the average weight percentage of various organs, calculated on the average total weight in such a way that for each individual specimen for each organ of this specimen the bodyweight percentage is calculated and from this the average of all the cases in each intra-uterine month is given. He also gives the variations, adding the minimum and maximum values. Since also the absolute bodyweights are mentioned, the average absolute weight of each organ may be easily calculated from his tables.

Evidently the average weights do not represent the condition at the beginning or at the end of a month, each average being taken over a whole month. Yet the average date of the month for which the average weight figures hold good, may be calculated with a fair degree of accuracy, the more so as the average body weights at the end of each month are calculated after the data of AHLFELD, LEGOU, FEHLING and MICHAELIS. The curve constructed by means of these averages is the ideal mean of the curves constructed after the data of each of these authors which do not run exactly parallel, especially not for the end of the prenatal period.

For the postnatal period we used VIERORDT's figures [2]) which were also critically selected by this author from data from various sources.

The number of brains whose weight was taken was 483, distributed over 25 years. A disadvantage of VIERORDT's means is that the figures used for making it, were not first calculated individually as JACKSON did. VIERORDT's figures have been partly corrected by DONALDSON [3]). Of these postnatal data only male specimens were used.

Especially the averages of these brainweights suffer from a certain lack of exactitude

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1) JACKSON, C. M. On the Prenatal Growth of the Human Body and the relative Growth of the various Organs and Parts. The American Journal of Anatomy, Vol. IX.

2) VIERORDT, H. Daten und Tabellen für Mediziner, Jena (1906).

3) DONALDSON. The growth of the brain. London (1898).

by the relatively small number of specimens in some age periods. This as well as the fact that the postnatal data concern periods of a whole year and do not give the condition at the end of such a year also explains that — according to these figures — the brainweight does not continually increase after birth but sometimes gives a lower average for an older year. This does not agree with what may be expected in a period of growth and apparently is due to an insufficiency of reliable data. —

Since curves are more instructive than a series of figures to indicate the increase of brain- and bodyweight, we give in fig. 1 the logarithmic curves of their evolutionary increase up to the 25th year.

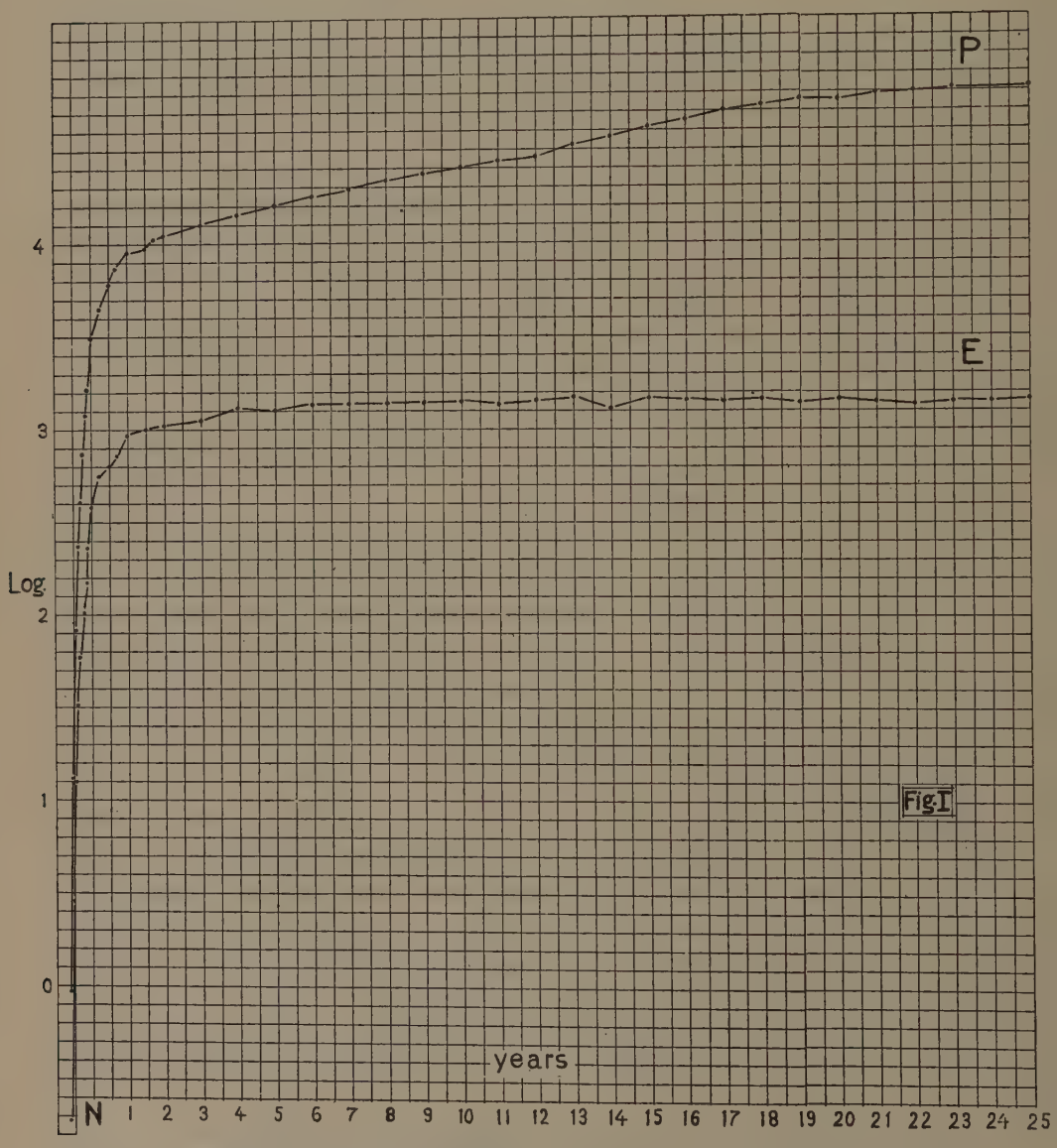

Fig. I. Graph of the logarithmic grouwth of brain- (E) and bodyweight (P) from the second intra-uterine month to the twenty-fifth year, after JACKSON's and VIERORDT's data. Time on the absciss, logarithms of the weight in grammes on the ordinate.

As is well known, growth usually is a more or less cyclic process in which the rapidity shows maxima and minima. If we draw a monocyclic growth curve by a graph in which time is put on the absciss and weight on the ordinate, this graph will be *S*-shaped. It is furthermore known (FAURÉ—FREMIET [1]), ROBERTSON [2]) a.o.) that the human organism as a whole passes through at least three of such cycles, the first of which, covering the whole fetal period, is not yet finished at birth but some time after it. The second cycle has a maximum about the 5th year, while the third, having its maximum at puberty, only finishes in the adult.

These cycles are also observed in studying JACKSON's and VIERORDT's bodyweight figures. They even are indicated more or less in fig. 1. It appears that the first cycle, which for its greater part covers the fetal period, is more important for the final weight of the body as a whole than the following cycles, the rapidity of growth, i.e. the increase of weight per time unit, relatively and logarithmically expressed, being much greater than in the postnatal cycles, the rise of the fetal curve being much steeper than in the postnatal curves. From the figures it furthermore appears that the first cycle ends between the second and third year [3]), when the second cycle begins, as is also shown in our curves by the strongly diminished rise of the growth line in the second and third year. After this year again a new but small rise occurs, obtaining its maximum at the 5th year.

This maximum is much smaller than that in the first, chiefly fetal cycle where it coincides approximately with the 9th intra-uterine month and it is also smaller than the maximum in the third cycle which lies between the 15th and 16th year.

Turning to the growth curve of the brain, we find that here also at least three cycles occur, each showing a distinct maximum. The first one, covering the fetal period, has the greatest percentual maximum of all, just as in the growth curve of the bodyweight, and, similarly as the latter, it only ends after birth about the second year. Its maximum coincides with the ninth intra-uterine month.

Owing to the lesser exactitude of the data concerning postnatal brain-weights, the following cycles cannot be well determined. Yet, a closer analysis shows that certainly two postnatal maxima occur, proving the existence of two cycles, the first postnatal maximum falling between the 3rd and 4th year, the second or last one in puberty, about the 13th year.

Contrary, however, to what was found with bodyweight, the maximum increase of brainweight of the second cycle — in the 4th year — is

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1) FAURÉ-FREMIET, E. La Cinétique du développement. Paris (1925).

2) ROBERTSON, B. On the normal rate of growth of an individual and its biochemical significance. Archiv. für Entwickl. Mech. Bd. XXV. Idem, Further remarks. Ibidem Bd. XXVI.

3) According to the data used by ROBERTSON (i. l. c.) the first growth cycle finishes at the end of the first natal year.

percentually larger than the maximum increase of the third cycle, coinciding with the 13th year.

Apart from the above-mentioned maxima, another though very small maximum seems to occur in the 9th year. The figures hitherto available however, are too uncertain to consider this maximum as indicating a cycle of its own and it may be better to consider it as a preceding indication of the maximum at the onset of puberty.

Resuming our results concerning brain- and bodyweight, we find that in both processes at least three cycles occur, the maxima of which are such that those of the brainweight occur about the same time (slightly earlier) as those of bodyweight. In both processes the first cycle closes about the second year, the second runs from the second to the 7th year, when the last cycle begins, which closes with adult life. Furthermore in both processes maxima occur at the 9th intra-uterine month, about the 4th—5th year and at the onset of puberty.

Consequently there is a close parallelism in the growth of body and brain. The *S*-shape of the first cycle of brain increase is seen in fig. 2, which at the same time shows that this cycle is not an ideally symmetric one.

As ROBERTSON [1]) pointed out, a monocyclic *S*-shaped growth curve is very similar to a graph of an autocatalytic reaction. In such reactions the products resulting from it, act as a catalyser on the reaction itself. This causes the rapidity of the reaction to increase at the beginning pari passu with the increase of reaction products. This possibility, however, being limited by the consumption of the necessary material, the rapidity of reaction, after having attained a maximum, again decreases to reach the zero point, when the available material is exhausted.

This parallelism of growth curves and autocatalytic reactioncurve induced ROBERTSON — without sufficient explaining it biologically — to express these curves by the formula $Log \frac{x}{A-x} = K\ (t-t^1)$ (for the deduction of this formula see footnote [2]), for its greater reliability than that of other formulae of relation see footnote [3]). In this formula $x =$ weight of the growing organ or organism at the time t, $A =$ its maximum weight at the end of the growth cycle and $t^1 =$ the time at which half of this maximum weight has been attained. K is a constant that may be calculated for a given value of x at a given time t.

HERINGA [4]) gave us various arguments to show that this relation may be

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[1]) ROBERTSON, l.c.

[2]) ROBERTSON, l.c. Bd. XXV.

[3]) ROBERTSON, B. Explanatory remarks concerning the normal rate of growth of an individual and its biochemical significance. Biologisches Zentralblatt. Bd. XXX (1910).

[4]) HERINGA, G. C. Organische opbouw en afbraak. Vlaamsch Geneesk. Tijdschr. N⁰. 3 (1929).

understood, starting from the hypothesis that, generally speaking, the intensity of a biological process is a function of one of the products resulting from it.

From ROBERTSON's examples it appears that his formula is widely applicable in zoological as well as in botanical processes of growth. Elaborating this conception, ROBERTSON used the same formula as a point of issue for the mathematical expression of the relation between the growth of the body and one of its organs, applying the following formula: $Log \frac{x^I}{A_I - x^I} = a\, Log \frac{x^{II}}{A_{II} - x^{II}} + b$, in which x^I and x^{II} are the weights of the organ and of the organism at the same time; A_I and A_{II} the respective maximum weights and a and b two constants, calculated according to the method of the least squares. Substituting VIERORDT's data in this formula, ROBERTSON finds the following relation between brain- and bodyweight: $Log \frac{X^I}{1.5 - X^I} = 1.723\, Log \frac{X^{II}}{66.3 - X^{II}} + 1.675389$, in which X^I is the brainweight, X^{II} the bodyweight at a given age and 1,5 and 66,3 the final maximum values of brain- and bodyweight, expressed in kilogrammes [1]).

With this formula ROBERTSON calculates by substitution the brainweights going with certain bodyweights in the postnatal period. That his results are quite conform to the reality appears from the following table:

TABLE I.

Age	Bodyweight	Brainweight		Difference $\pm \frac{\text{calc.} \pm \text{observ.}}{\text{observ.}} \cdot 100\%$
		Observed	Calculated	
Neonatus	3.1 K.G.	0.381	0.311	— 18.3 %
1st year	9.0 „	0.945	0.991	+ 4.8 %
5th year	15.9 „	1.263	1.300	+ 2.9 %
10th year	25.2 „	1.408	1.430	+ 1.5 %
15th year	41.4 „	1.490	1.487	— 0.2 %
20th year	59.5 „	1.445	1.499	+ 3.7 %
25th year	66.3 „	1.431	1.500	+ 4.8 %

In this table the difference between the calculated and observed brainweights varies from 0.2—18.3 %.

[1]) According to two mathematicians I consulted in this matter, ROBERTSON may have committed a mistake in applying the method of the least squares (ROBERTSON l.c. Arch. Entwickl. Mech. Bnd. 25). Correcting this mistake, we get as value for the constants 1.711 and 1.663, a difference not large enough to give considerable changes in the above-mentioned table.

Applying the same formula to the fetal period, we observed that the differences were far greater, varying from 51.4 %—99.8 %, so that apparently this formula, though giving good results for the postnatal period, is not applicable to the fetal period.

This, however, is not strange. If we consider fig. 3, giving the curve of the relation between body- and brainweight unto the 10th year, we see that the shape of this curve in the fetal period is very different from that in the postnatal period, for which ROBERTSON used his formula.

Yet, it appeared to me that ROBERTSON's basis formula of relation may be applied to the fetal period. Following his method, we found another mathematical expression for the relation between brain- and bodyweight during the fetal period and the two first years after birth — thus covering what is called the first growth cycle:

This mathematical expression is as follows:

$$Log \frac{X^{I}}{1.0254-X^{I}} = 0.8943\ Log \frac{X^{II}}{11.0-X^{II}} + 0.1022.$$

The adjoining table gives the results obtained with this expression:

TABLE II.

Age	Bodyweight	Brainweight		Difference
		Observed	Calculated	
1st year	9.0	0 9447	0.8503	— 9.9 %
Neonatus	3.1	0.381	0.3630	— 4.7 %
In 9th intra-ut. mth.	1.609	0.232983	0.212390	— 8.8 %
In 8th „ „	1.196	0.149022	0.153836	+ 3.2 %
In 7th „ „	0.784	0.102999	0.111292	+ 7.1 %
In 6th „ „	0.4131	0.059073	0.066692	+12.8 %
In 5th „ „	0.2340	0.032666	0.040595	+24.2 %
In 4th „ „	0.08088	0.012714	0.015890	+24.9 %
In 3rd „ „	0.01496	0.002865	0.003537	+23.4 %
In 2nd intra-ut. mnth.	0.000904	0.000185	0.000288	+55.6 %

The difference between observed and calculated brainweights, after substitution of the bodyweights according to JACKSON's data, now only varies between 3.2 % and 24.9 %, so that with the above-mentioned formula we obtained a somewhat more satisfactory mathematical expression for the body-brainweight relation in the fetal period conform to and thus confirming ROBERTSON's supposition.

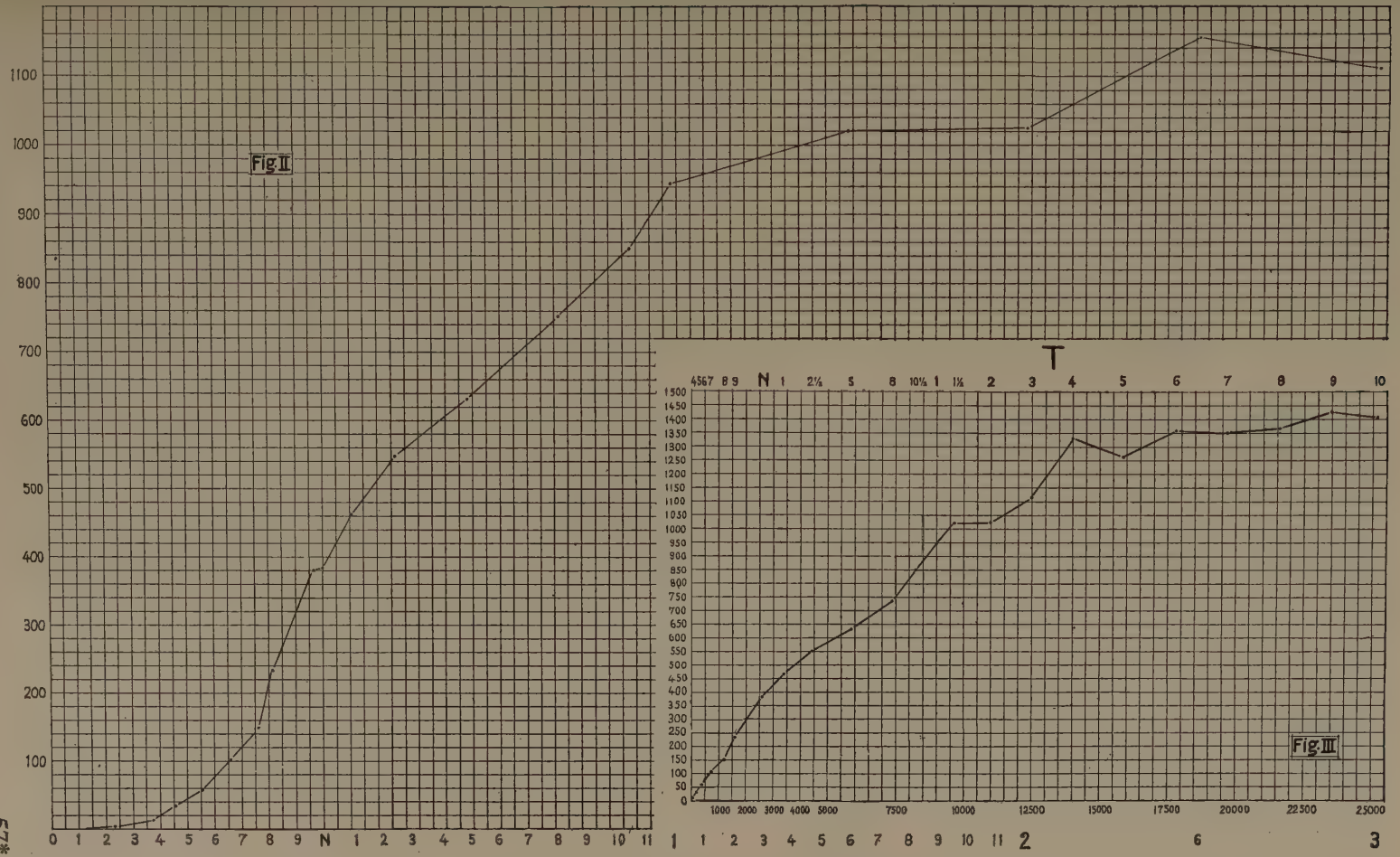

Fig. II. Graph of the absolute growth of the brain from the second intra-uterine month to the third year. Time on the absciss, weight in grammes on the ordinate; after JACKSON's and VIERORDT's data.

Fig. III. Graph of the relation curve of body- and brainweight. Bodyweight in grammes on the absciss, brainweight on the ordinate, also in grammes. Above the absciss, parallel to it, time is given; after JACKSON's and VIERORDT's data.

The discrepancies between observed and calculated values are certainly due to the quality and quantity of the material, as is most evident in the youngest intra-uterine month of which only three objects were available. Besides, these discrepancies will become less, if the upper limit of the first growth cycle will be more exactly established and with the increase of the reliability of the other data, necessary for this sort of work. This holds good specially for the first five fetal months.

This much appears that the relation between brain- and bodyweight may be expressed fairly exactly for the whole ontogenetic development by the following two mathematical formulae which, though equal in character, differ by their constants and their maximum values, at the same time showing that the relation in the first cycle differs a good deal from that in the second and third.

For the first growth cycle — including fetal life plus the first two years of natal life — the formula is:

$$Log \frac{X^{I}}{1.0254-X^{I}} = 0.8943\, Log \frac{X^{II}}{11.0-X^{II}} + 0.1022;$$

for the rest of postnatal life, i.e. for the two cycles following the 2nd year, the formula is:

$$Log \frac{X^{I}}{1.5-X^{I}} = 1.723\, Log \frac{X^{II}}{66.3-X^{II}} + 1{,}675389.$$

The shape of the curves expressing these formulae as far as they are real, is thus, in some degree, indicated in the continuous line of fig. 3 from the 4th intra-uterine month unto the 10th year.

A totally different way to analyse growth processes is by using growth curves of the total organism in which the percentual increase per time unit is expressed, as was done by MINOT [1]) a.o.

For this purpose a diagram is made of the number of weight percentages to be added to a body in a special time unit (period), so that the final weight would be normal at the end of that period.

This number of percentages might then be inserted graphically at the beginning of that period. One might call this potency of increase, expressed in percentages, the "growth energy".

Already MINOT pointed out that this "growth energy", with all organisms without any exception, is very large in an early ontogenetic period, decreasing gradually until it reaches the zero point [2]) in attaining the adult stage.

The developmental increase of the parts of an organism, i.e. of separate organs, shows the same. In fig. 4 we give the curves of the percentual increase of brain- (E) and bodyweight (P) to the 2nd year, calculated with

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[1]) MINOT, CH. S. The problem of age, growth and death. The popular Science Monthly, Vol. LXXI (1907).

[2]) Also JACKSON and MÜHLMANN (quoted by JACKSON l.c.).

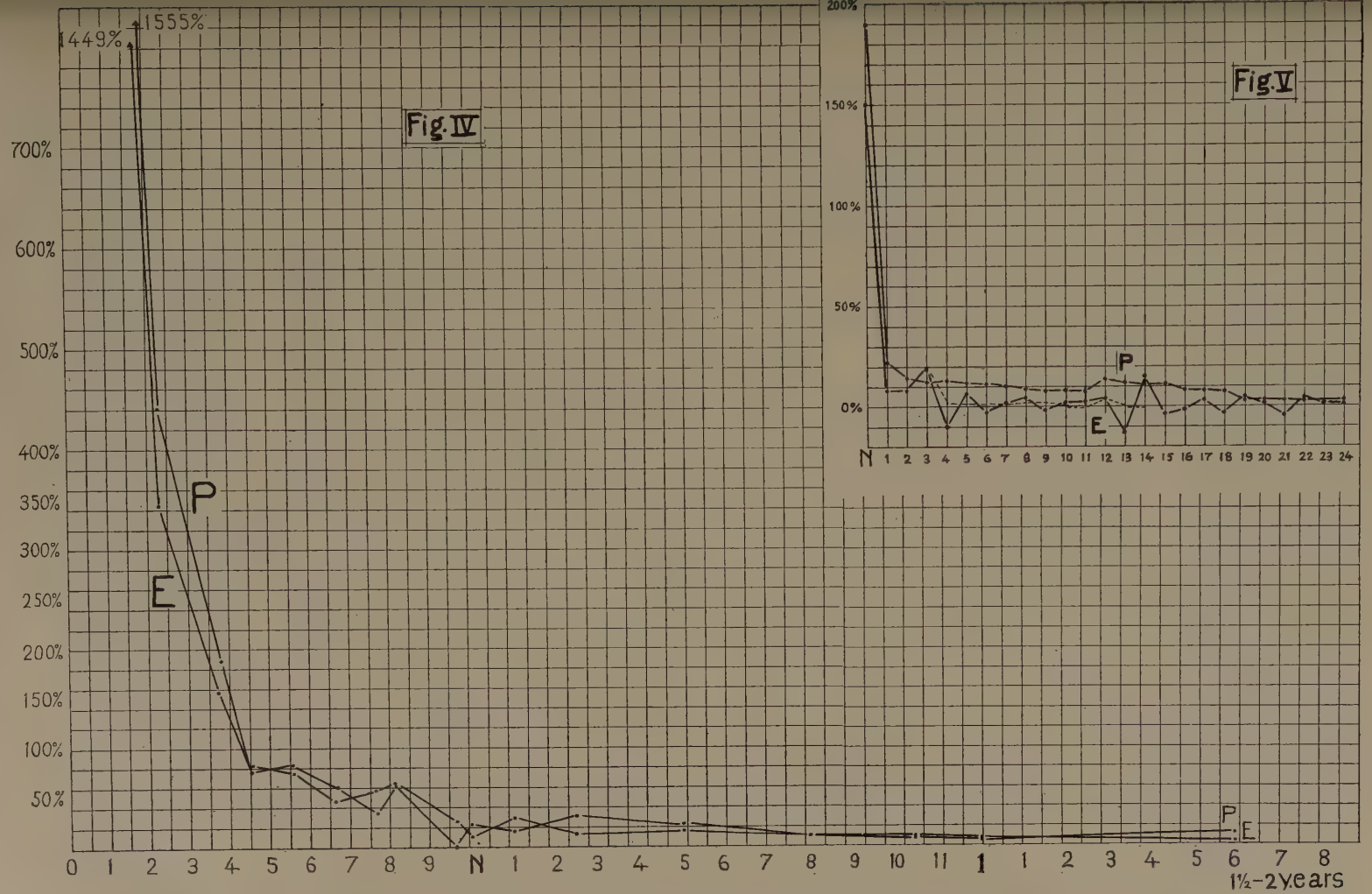

Fig. IV. Graph of the percentual increase of body- and brainweight from the second intra-uterine month to the 1½ year (see text). Time on the absciss. Percentual increase on the ordinate; after JACKSON's and VIERORDT's data.

Fig. V. Graph of the percentual annual increase of body- and brainweight from birth till the 25th year; after VIERORDT's data. Dotted line: curve of brain increase after eliminating the negative values.

JACKSON's and VIERORDT's data. In both curves the increase of the average data of each i.e. the "growth energy", is very large from the second to the third intra-uterine month, viz. 1449 % and 1555 %. The curves then descend rapidly, although the periods between which the percentages have been calculated are approximately the same. In other words there is a pronounced slowing down of the percentual weight increase per time unit, which again rises somewhat before birth about the period of the maximum weight increase of the first cycle.

In fig. 5 about the same is seen. This figure shows the percentual increase in periods of one year according to VIERORDT's data. As pointed out above (p. 872) there are no absolute periods of one year between these data. Yet also here we see small rises of the curves between the 4th and 5th year and at the onset of puberty, corresponding with the maxima of the two postnatal growth cycles.

In figs. 4 and 5 some points are striking. First of all the fact, that also here the growth curves for brain- and bodyweight run practically in the same way, the character of both curves being very similar. This was to be expected after what has been said above.

It furthermore appears that the absolute difference in percentual increase between body and brainweight — so pronounced at the beginning of ontogenetic development — very soon decreases, though even this small difference in the last part of development has to be considered as relatively important.

Finally the relation between the growth energy of body and brain in the fetal period comes very near the value 1, as shown by our calculations. This does not hold good for the postnatal period, in which this relation, though much more variable, with the exception of the first four years remains far above the value 1. — The relation between the percentual increase of body and brainweight calculated over the whole fetal period, i.e. from JACKSON's second month's data till birth, is 1.4. For the postnatal period to adult age it is 6.9.

At the beginning of ontogenetic development, when the percentual increase of both body- and brainweight per time unit is very high, the differences between the whole organism and the organ are larger than later on when this increase for body and brain and also their absolute difference is small. In the fetal period their relation, however, is about 1, whereas — as stated above — this relation in the postnatal period is much higher.

The difference in relative weight (and size) in various periods between body and brain, i.e. the smaller relative weight of the brain in the adult compared to the beginning of the postnatal period, is an expression of the relatively greater percentual increase per time unit of the total organism in the intervening period, although the difference of its absolute value compared to the "growth energy" of the brain is small.

Anatomy. — *The diencephalic and some other systems in Xantharpyia amplexicaudata.* II. By NAOKICHI SUZUKI. (Dutch Central Institute for Brain Research, Amsterdam. Department of Anatomy, Manchuria Medical College, Mukden.) (Communicated by Prof. C. U. ARIËNS KAPPERS.)

(Communicated at the meeting of May 23, 1936).

The subthalamic and hypothalamic region.

The most conspicuous nuclei of the subthalamic region are the entopeduncular nucleus, the corpus subthalamicum, (LUYS), separated from it by FOREL's bundle, and caudo-medially to the latter the unpigmented substantia nigra. In the hypothalamus the most distinct cell groups are the autonomic nuclei and the mammillary and ectomammillary nuclei.

The *entopeduncular nucleus,* so conspicuous in all animals below the mammals by the location of its large cells in what is called there the lateral olfacto-hypothalamic and tegmental tract, lies in what RIOCH (l.c. III p. 374) calls the lateral hypothalamic area, consisting of large cells interpolated in the *basal olfactory tract.* This bundle, best described by WALLENBERG [1]), evidently is the homologue of the tr. olfacto-hypothalamicus et tegmentalis lateralis of Submammals.

The basal olfactory bundle of WALLENBERG, indicated by GURDJIAN and RIOCH as medial forebrain bundle [2]), consists of several groups of fibers derived from the basal part of the forebrain chiefly from the lateral olfactory area, partly from the medial olfactory area. It may contain also fibers from the amygdala. Its strongly medullated bundles gather at the rostral pole of the diencephalon over the chiasm (fig. 2: B.O.B.) and from there pass caudally through the lateral preoptic and the hypothalamic area. It can be easily traced (figs. 4—9) to the external mammillary nucleus, while some of its fibers reach the level of the nucleus interpeduncularis and tegmentum. Marchi degeneration of its strongly myelinated fibers enabled WALLENBERG to trace some of them even into the posterior longitudinal fascicle. Normal preparations do not allow to do so but I have no reason to doubt his statement. The cells lying in this tract may be

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1) WALLENBERG, A. Das basale Riechbündel des Kaninchens. Anat. Anz. Bnd. 20, p. 175 (1901).

2) This bundle is called by several American neurologists medial forebrain bundle, to distinguish it from the laterally running capsular peduncular system. However, in the telencephalon it originates chiefly lateral to the capsula and in the diencephalon runs in the lateral hypothalamic area. The name medial forebrain bundle might be reserved to the septal (fimbrial) part of the fornix, which evidently corresponds to the tr. olfacto-hypothalamicus medialis of lower animals having also the same relation to the autonomic periventricular nucleus.

divided into two groups: 1°. a group of cells lying in the rostral part of the diencephalon (fig. 2), corresponding perhaps to REICHERT's nucleus innominatus; 2°. a more caudal group in front of the external mammillary body and extending from the lateral border of the tuber medially into the direction of the infundibulum, reminding more or less of the large cells of the tubero-mammillary nucleus described by various authors in higher mammals.

The *corpus subthalamicum* of LUYS (C.S. figs. 7, 8, 9), not large but quite evident in my material, is ventrally surrounded by the system of the ansa lenticularis lateralis that will be dealt with in the description of the pes pedunculi, since frontally its fibers run with the cerebral peduncle, gradually leaving it to end partly behind this nucleus. Right in front of the corp. subthalamicum the hypothalamic bundle of FOREL (F. figs. 5, 6 and 7), arising from the ventral edge of the capsula interna, turns medially to approach the bundle of VICQ D'AZYR (M.T.).

The *magnocellular autonomic nuclei* are quite conspicuous by the large size of their cells. The ventro-lateral one, the *nucleus supra-opticus basalis lateralis* extends from in front of the level of the anterior commissure till some sections behind this commissure. A primitive feature of this nucleus in my object, by which it contrasts strongly with rabbits and dogs, is that so few of its cells extend over and behind the chiasm forming a *nucleus basalis postopticus*. A few of such cells occur in fig. 2 (N.B.P.O.). The latter nucleus, however, is very small even compared with Rodents [cf. GRUENTHAL [1])]. Both are indicated by RIOCH as nucl. tangentialis.

The dorso-medial autonomic nucleus, the *nucleus filiformis* or *periventricularis magnocellularis*, extends from immediately behind the anterior commissure, right underneath the commissurae griseae along the upper portion of the infundibulum, to the level of my fig. 3 as a triangular group of cells (P.M. figs. 2, 3). A separation in an anterior and a posterior or principal group (RIOCH) does not exist, but the posterior part is the larger one, as it is in the dog. Laterally to it the finally medullated septal (fimbrial) bundles of the fornix (f.) connect with it, as does the medial (septal) olfacto-hypothalamic tract in fishes. Corresponding with the extension of this nucleus the ependyma of the ventricle is somewhat higher and slightly more folded as first described by KAPPERS (l.c.s.) and CHARLTON [2]), a phenomenon probably due to secretory function of this nucleus [SCHARRER [3]) and KUROTSU [4])]. Ventro-laterally to this nucleus RIOCH's

[1]) GRÜNTHAL, E. Der Zellaufbau im Hypothalamus des Kaninchens und des Macacus rhesus nebst einigen allgemeinen Bemerkungen über dieses Organ. Journ. f. Psychol. u. Neurol. Bnd. **42** (1931).

[2]) CHARLTON. A glandlike ependymal structure in the brain. Proc. Royal Acad. Amsterdam, Vol. **31**, p. 823 (1928).

[3]) SCHARRER, E. Stammt alles Kolloid im Zwischenhirn aus der Hypophysis? Frankfurter Zeitschr. f. Pathol. Bnd. **47**, p. 134 (1934).

[4]) KUROTSU, T. Ueber den Nucleus magnocellularis periventricularis bei Reptilien und Vögeln. Proc. Royal Acad. Amsterdam, Vol. **38** N°. 7 (1935).

area *hypothalamica anterior* extends with small cells which at the bottom of the infundibulum again aggregate in a more distinct group: RIOCH's *nucl. ovoides.*

Further caudally on the ventral and lateral side of the hypothalamus three nuclei are seen: the internal and external mammillary nucleus and the ectomammillary nucleus or nucleus of the tr. peduncularis transversus.

At the frontal pole of the thalamus, behind the com. anterior, the *fornix* (f.) consists of coarse lateral fibers, arising from the hippocampal cortex, and finely medullated medial fibers arising laterally in the fimbrial (supra commiss.) part of the septum and swinging dorsally over the coarser fibers to reach their mesial side. As stated above, the septal fibers end around the nucl. paraventricularis anterior (parvocellularis P.V.A. fig. 1) and the nucl. paraventricularis magnocellularis (sive filiformis). These fibers may have an autonomic function, considering the parasympathetic affects obtained by HESS [1]) in stimulating the septum. They probably are homologous to the medial forebrain bundle of lower animals, whose connection with the periventricular autonomic nucleus was demonstrated by KAPPERS [2]).

The dark fibers running laterally to these, the fornix proper, enter the pars lateralis of the *nucleus mammillaris* at about the same level with the origin of the tractus mammillo-thalamicus. Most of them connect with the lateral body but some of them run into the medial body toward the midline. More caudally some fibers of both sides decussate in the *nucleus supramammillaris,* the bed-nucleus of these crossing fibers, located at the level of the ventral portion of the comm. supramammillaris (S.M.C. fig. 10). As stated before, the tractus mammillo-thalamicus arises from the internal mammillary body, (I. fig. 10), only few fibers originating in the lateral or external mammillary body. (E. fig. 10).

The latter nucleus is conspicuous chiefly by giving origin to the strongly medullated descending *mammillary peduncle,* as experimentally proved for the rabbit by VAN VALKENBURG [3]). Besides, it may receive a component of the medial lemniscus [WALLENBERG [4])]. Laterally to the external mammillary nucleus, between this nucleus and the medial edge of the peduncle, some large cells occur, that would hardly be seen, if they were not connected with the distinct *tr. peduncularis transversus externus* (T.P.T. figs. 10—12), which from here may be traced caudo-laterally over the ventral

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[1]) HESS, W. R. Le sommeil. Réunion de la Société de Biologie, p. 1 (1931).

[2]) The phylogenetic development of the hypothalamic autonomic centers. Report for the International Congress of Neurology, London, 1935 (Manuscript).

[3]) VAN VALKENBURG. Caudale verbindingen van het corpus mammilare. Versl. der Kon. Akad. v. Wetensch. March (1912).

[4]) WALLENBERG, A. (1900). Notiz über einen Schleifenursprung des Pedunculus corporis mammillaris beim Kaninchen. Anat. Anz. Bnd. VI, N°. 5 u. 6. Sekundäre sensible Bahnen im Gehirnstamme des Kaninchens, ihre gegenseitige Lage und ihre Bedeutung für den Aufbau des Thalamus. Anat. Anz. Bnd. XVIII, N°. 4 und 5.

surface of the peduncle, as described by FREY [1]), to ascend caudally on its lateral side to the caudal pole of the medial geniculate body. This nucleus corresponds to the ectomammillary nucleus described by KOSAKA and HIRAIWA [2]), the basal optic nucleus of FREY. Curiously enough, the basal optic fibers ending in this nucleus are very difficult to trace, while the tr. peduncularis transversus arising from it is very distinct, so that I agree with FREY in considering the latter not as a continuation but as a secundary neurone of the basal optic system.

The Metathalamus.

Of the *nuclei geniculati laterales* the smaller *ventral nucleus* (G.L.V., figs. 9—10) is separated from the large nucl. geniculatus lateralis dorsalis by a small medullary layer (D.). Receiving fibers of the optic tract, another thick bundle leaves this nucleus to run dorso-medially. Most of these fibers belong to the tractus geniculo-tectalis, others may be connections with the dorsal nucleus. Finer fibers derived from this nucleus run medially into the caudal part of the formatio reticularis and descend medio-ventrally into the zona incerta, as described by various authors.

The *nucleus geniculatus lateralis dorsalis* not labelled in fig. 8—11, but covering the whole area between Pu and G.L.V., is much larger. From this nucleus the geniculo-cortical connection arises, which in this animal is difficult to trace on account of its mixing up with the optic tract fibers. This nucleus continuer gradually in the pulvinar.

In the hilus of the ventral geniculate nucleus a number of well-stained fibers occur, which come from the occipital radiation. These evidently are the fibers described by D'HOLLANDER and RUBBENS [3]) (l.c.p. 306) as „une voie cortifugale dans le tiers externe du pédoncule cérébrale pour aller se terminer dans le tubercule quadrigeminal antérieur". I believe they are the same bundle described long before by K. H. BOUMAN [4]) (l.c.p. 40 and 79) and confirmed by BIEMOND) [5]) as a cortico-fugal system (from the occipital lobe) running in the utmost lateral part of the peduncle and from there through the ventral geniculate nucleus to end in the dorsal geniculate nucleus and in the anterior quadrigeminal body. Some of its fibers remain in the pes pedunculi, as also found by BOUMAN and by D'HOLLANDER.

The *medial geniculate nucleus* (G.M.) is large, owing to the great deve-

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[1]) FREY. Die basale Optische Wurzel des Meerschweinchens. Proc. Royal Acad. Amsterdam, Vol. 38, p. 781.

[2]) KOSAKA and HIRAIWA. Zur Anatomie der Sehnervenbahnen. Folia Neurobiologica, Bnd. 9 (1915).

[3]) D'HOLLANDER and RUBBENS. Recherches anatomo-expérimentales sur la constitution du pédoncule cerébrale et ses constituents sous-thalamiques. Revue neurologique. Tome I, p. 289 (1926) (see specially p. 306 and fig. 19).

[4]) K. H. BOUMAN. Experimenteele onderzoekingen over het cerebrale optische stelsel. Diss. Amsterdam (1905).

[5]) A. BIEMOND. Experimenteel-anatomisch onderzoek omtrent de corticofugale optische verbindingen bij aap en konijn. Diss. Amsterdam (1929).

lopment of the lateral lemniscus. The brachium of the inferior colliculus appears at its medio-ventral border and mostly distributes in this area. Some of its fibers enter the upper layer of the anterior colliculus. (fig. 12). The *temporal fibers* originating in this nucleus gather at its dorsal side chiefly and may be traced into the internal capsule passing the medial side of the lateral geniculate (fig. 9). In the rostral pole of the nucleus geniculatus medialis fibers from the GUDDEN's commissure end, in its caudal pole the very distinct tr. peduncularis transversus externus.

The *lateral lemniscus* ascends to enter the posterior colliculus and the medial geniculate body. The most lateral fibers of this lemniscus enter the colliculus posterior, its medial fibers continue more frontally, then swing laterally into the medial geniculate nucleus.

On the level of the IV root exit two groups of large cells are imbedded in the lateral lemniscus. The most ventral group is the frontal end of the nucl. ventralis lemnisci lateralis. The dorsal group corresponds with the magnocellular part of the *ganglion isthmi* of lower animals. It is the same cell group as described by GEREBTZOFF [1]), MARBURG [2]), WINKLER and POTTER [3]) as *nucl. lemnisci lateralis dorsalis*. PRECECHTEL [4]) was the first to realize its homology with the large cells of the ganglion isthmi, a viewpoint confirmed by LE GROS CLARK [5]). Apart from lateral lemnicus fibers it may receive fibers of the spino-mesencephalic tract, ascending laterally to the lateral lemniscus.

The *brachium conjunctivum anterius* or tractus cerebello-diencephalicus originates from the lateral or dentate nucleus and the nucleus tecti. The dentate nucleus, the largest of the two, lies very lateral, very near the cortex of that part of the hemisphere of the cerebellum that lies on top of the flocculus. The brachium swings ventrally around the ventricle. The first crossing of its fibers occurs directly under the fasciculus longitudinalis medialis (dorsalis). More frontally the crossing extends further ventrally. After decussation, the fibers proceed and most of its dorsal fibers end in the nucleus ruber, (N.R. fig. 12) which — as in most lower mammals — consists of large cells chiefly (cells of the rubro-spinal tract). Some more ventrally and more frontally crossing fibers of this tract leave the chief bundle and join the medial lemniscus in the lamina medullaris externa, running laterally along the lower end of the fasciculus retroflexus. They may be traced frontally in the zona incerta above the corp. subthalamicum.

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[1]) GEREBTZOFF. Recherches anatomo-expérimentales sur la région du lemniscus latéral et ses commissures. Journ. Belge de Neurologie et de Psychiatrie, p. 73 (1936).

[2]) MARBURG. Atlas des menschlichen Zentralnervensystems. Wien (1910), (fig. 32).

[3]) WINKLER and POTTER. An anatomical guide to experimental researches on the cat's brain, Amsterdam (1914), (Plate XXI).

[4]) PRECECHTEL. Some notes upon the finer anatomy of the brainstem and basal ganglia of Elephas indicus. Proc. Royal Acad. Amsterdam, Vol. 28, p. 89 (1925).

[5]) LE GROS CLARK. The medial geniculate body and the nucleus isthmi. Journ. of Anatomy, Vol. 67, p. 536 (1933).

Pes pedunculi and ansa lenticularis (Kammsystem).

Contrary to most mammals the pes pedunculi of Xantharpyia is easily analyzed, even on normal preparations. It consists of very deeply and faintly myelinated bundles. Of the deeply stained fibers the most lateral group, apparently corresponding to the tempero-pontine tract, is lost in the pons in which they gradually enter, starting at the frontal pole of the pons, swinging medially underneath the pyramidal fibers.

Whether any of the medial fibers of the peduncle enter the pons as fronto-pontine fibers is not sure. If so, they are certainly few.

In the meanwhile the rest of the deeply stained bundles change their flat arrangement to a round bundle. The round bundle thus remaining is the pyramidal tract, most of which fibers decussate on the level of the facial nucleus [proximal pyramidal decussation of DRÄSECKE [1]), HATSCHEK [2]) and FUSE [3])]. Very few fibers of the pyramid reach the beginning of the cervical cord decussating to the dorso-lateral column.

Thus far as concerns the deeply stained fibers of the pes pedunculi.

The faintly stained peduncular fibers form different systems:

A bundle of brownish stained fibers (A.L.) in the lateral part of the peduncle is chiefly connected with the putamen. The light colour of these fibres is very distinct at P.T. fig. 1 and A.L figs. 3, 4 and 6.

They gather at the fronto-lateral side of the globus pallidus. At the level of the anterior commissure they lie underneath its lateral arm, between this and the basal olfactory bundle. Further backward they run between the optic tract and the deeply stained capsule fibers (fig. 6), proceeding in the lateral part of the peduncle, running in the ventral capsule of the corpus Luysii. Their position corresponds exactly to that of the fibers of the corpus Luysii as described by FERRARO (l.c. infra fig. 35, C.C.L.), but they also extend further backward in the lateral part of the substantia nigra. This may be called the *ansa lenticularis lateralis*, or lateral part of EDINGER's "Kammsystem".

I believe that the least myelinated fibers forming the majority of this bundle establish an ascending connection with the putamen. while some of its better myelinated fibers may be descending ones. The first mentioned fibers may be the same as the thalamo-strial tract appearing at the 8 m.m. stage in cat embryos [WINDLE [4])], the more so as also WINDLE found

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[1]) DRÄSECKE. Zur mikroskopischen Kenntnis der Pyramidenkreuzung der Chiropteren An. Anz. Bnd. **23**, p. 449 (1903) (Pteropus ursinus).

[2]) HATSCHEK. Ueber eine eigentümliche Pyramidenvariation in der Säugetierreihe. Arb. a. d. Neurologischen Institut der Wiener Universität, Heft **10** (1903). (Pteropus edulis).

[3]) FUSE. Vergl. anat. Beiträge zur Kenntnis über die sog. obere zweite oder proximale Pyramidenkreuzung bei einigen Edentaten sowie bei einigen fliegenden Säugern. Arb. a. d. Anat. Institut der Univ. Sendai, Heft **12** p. 47 (1926). (Pteropus edulis, Pteropus pselephon and one not determined species of Pteropus).

[4]) WINDLE, Neurofibrillar development of cat embryos etc. Journ. of Comp. Neurology, Vol. **63**, p. 139 (1935).

these fibers spreading in the lateral part of the striatum (accompanied by fibers ending in the lateral cortex).

Another bluish stained bundle (A.M. figs. 2—12) arises from the globus pallidus (G.P., fig. 1) and nucl. accumbens. It accompanies the former on its medial side. In front of the corpus Luysii this system is traversed by the hypothalamic bundle of FOREL: *F*. Hence it passes underneath the corpus subthalamicum to continue its course in the medial part of the peduncle. These fibers also finally leave the peduncle, but further backward than the lateral bundle. They end in the medial part of the substantia nigra, right in front of the pons and may be called ansa lenticularis medialis or better ansa pallidalis on account of their main origin. They form the medial part of EDINGER's „Kammsystem" [K. fig. 35 FERRARO [1])]. It is not to be excluded that some cortical fibers of the medial part of the capsula interna join this bundle. The latter however, are, certainly in the minority, so that I can fully confirm FERRARO's statement [2]) that the fronto-nigritic fibers chiefly arise from the striatum, especially in the globus pallidus. Although with normal preparations one cannot make sure whether a system is descending or ascending or both, I suppose, on account of its arising in the globus pallidus, that the medial system is chiefly descending (cf. also FERRARO).

[1]) FERRARO, A. Etude, anatomique du systême nerveux central d'un chien dont le pallium a été enlevé, Utrecht Hollande (1924).

[2]) FERRARO, A. Contributo sperimentale allo studio della substantia nigra normale e dei suoi rapporti con la corteccia cerebrale e con il corpo striato. Arrch. generale di Nevrologia, Psichiatria e Psicoanalisi. Vol. **1**, p. 1 (1925).

Embryology. — *Evocation, Individuation, and Competence, in amphibian organiser action.* By C. H. WADDINGTON and J. NEEDHAM. (Cambridge University.) (Communicated by Prof. M. W. WOERDEMAN.)

(Communicated at the meeting of June 27, 1936).

The interpretation of recent work on embryonic induction by chemical substances is one of the most important problems now confronting biologists. A very interesting discussion of it is given in a recent communication to this Academy by Professor M. W. WOERDEMAN [1]). Although this seems to issue in a damaging criticism of the current theories, we desire to suggest that his views in fact agree to a very large extent with those which were originally derived by WADDINGTON [2]) from his studies

[1]) M. W. WOERDEMAN, Proc. Royal Acad. Amsterdam, **39**, 306 (1936).

[2]) C. H. WADDINGTON Phil. Trans. Royal Soc. B., **221**, 179 (1932); C. H. WADDINGTON and G. A. SCHMIDT, Arch. Entw. Mech., **128**, 522 (1933).

of induction in the chick embryo and which have been developed by us in a series of papers dealing with inductive substances in the newt [3]).

WOERDEMAN's main conclusion is that the dead implants or chemical substances activate the cell material in some way, but that the production of the supernumerary embryonic axis is the work of the host itself, which is capable of reacting in this way to any activating stimulus. There are really two ideas involved in this conclusion: 1. that the host plays an essential part in the "induction" by a dead organiser, and 2. that the stimulus which proceeds from the implant is merely an indifferent activation.

With the first statement we can easily agree; indeed the first mention of this in the literature was made by one of us in connection with the action of dead organisers in the chick embryo [4]). We go further, for we have suggested a twofold division of the host's influence. On the one hand, the histological character of the induced tissues is determined by the particular kind of reactivity which is present in the ectoderm submitted to the inducing stimulus; thus there is only a certain period of development during which the host ectoderm will react to an inductive stimulus by the formation of neural tissue. The word *Competence* was suggested for reactivities of this kind (WADDINGTON [2])). On the other hand, a living organiser is known to be able to exert an influence on the regional character of an embryonic axis induced in its neighbourhood (SPEMANN [5]), WADDINGTON and SCHMIDT [2]), HOLTFRETER [6])). This influence on regional character we speak of as *Individuation*, and it seems quite certain that we must take into account the possible individuating influence of the host's organisation centre on embryonic axes induced by dead implants.

The advantage of analysing the host's influence into these two aspects is a gain in flexibility. Thus we can envisage the possibility of phenomena which involve competence but not individuation. HOLTFRETER's [7]) inductions by dead material in ectoderm removed from the host are perhaps an example, but a better case will be provided when we succeed in obtaining similar inductions performed by a mass containing a single active substance. WOERDEMAN gets into some difficulty in interpreting

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[3]) C. H. WADDINGTON, J. NEEDHAM and D. M. NEEDHAM, Nature, **132**, 239, (1933); J. NEEDHAM, C. H. WADDINGTON and D. M. NEEDHAM, Proc. Royal Soc. B., **114**, 393 (1934); C. H. WADDINGTON, J. NEEDHAM, W. W. NOWINSKY and R. LEMBERG, Proc. Royal Soc. B., **117**, 289; C. H. WADDINGTON and D. M. NEEDHAM, Proc. Royal Soc. B., **117**, 310 (1935); C. H. WADDINGTON, J. NEEDHAM and A. BRACHET, Proc. Royal Soc. B., **120**, 173 (1936); C. H. WADDINGTON, J. NEEDHAM, W. W. NOWINSKI, R. LEMBERG and A. COHEN, Proc. Royal Soc. B., **120**, 198, (1936); J. NEEDHAM, "Order and Life", Cambridge University Press (1936); J. NEEDHAM, Proc. Royal Soc. Med. Lond. (1936) (in the press).

[4]) C. H. WADDINGTON, Nature, **131**, 275 (1933).

[5]) H. SPEMANN, Arch. Entw. Mech., **123**, 389 (1931).

[6]) J. HOLTFRETER, Arch. Entw. Mech., **127**, 619 (1933).

[7]) J. HOLTFRETER, Arch. Entw. Mech., **128**, 584 (1933).

HOLTFRETER's results. The basis of his theory is that the dead organiser activates a "field" already existent in the ectoderm, but he also suggests that the fields are somehow bound up with the host's organisation centre and are therefore absent from the ectoderm in question, or at best only weakly developed in it; hence he is left with no explanation for the regular appearance of induced neural tissues in HOLTFRETER's explantation experiments. Here our two concepts give an easier formulation; the regular formation of induced tissues indicates that the competence of the ectoderm is normal, while the contorted and irregular shape of the inductions points to the weakness of the individuating influences. Further work is required before we can say whether isolated competent tissue retains some power of individuating into organs any tissues which may be induced in it, but the experiments of HOLTFRETER make it likely that the power, if any, is small.

The reverse of the above case is found when a piece of tissue individuates but does not exhibit competence; a normal induction by a living organiser provides an example, since the living organiser does not itself realise any competence for the formation of neural tissue although it does individuate the neural tissue which it induces. Here we are not concerned merely with the activation of a "field" in WOERDEMAN's sense, but are bound to consider also the determination of the regional character of the field; and it is exactly this determination which we call individuation. Finally, it may be mentioned that HOLTFRETER's [6]) experiments with implants of ectoderm on to older larvae have shown that at a stage when the competence to form neural tissue has entirely disappeared from the host ectoderm, a capacity to determine the regional character of induced neural tissue still persists; here again the single process of the activation of a field, spoken of by WOERDEMAN, has been broken up into two phases.

The second part of WOERDEMAN's thesis, namely, that the dead organisers provide merely an indifferent activating stimulus, is more open to criticism. It is a fact that substances have been described [3]) (such as certain sterols) which stimulate the ectoderm to intense proliferation but which have not yet given rise to induced tissues. The hypothesis that in more favourable cases they also will act as inducers remains a hypothesis, and one which does not seem to us plausible unless very cogent general considerations can be adduced in its favour. It seems to us that no such cogent reasons have been advanced. Thus the alleged induction of neural tissue by thermal or mechanical stimuli rests on a very slight foundation. There are only two papers in which it is asserted [8]). GILCHRIST and CASTELNUOVO exposed embryos to differential thermal gradients, but GILCHRIST's pictures show only irregular puckerings of the ectoderm the neural nature of which is uncertain, and one "Spaltung". Illustrations of CASTELNUOVO's results were never published, but she describes her positive

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[8]) F. G. GILCHRIST, Physiol. Zool., **1**, 231 (1928); G. CASTELNUOVO, Bollet. Zool., **3**, 291 (1932).

cases as "unite caudalmente", which strongly suggests "Spaltungen" and not proper inductions. The only convincing evidence of induction by an indifferent stimulus (implantation of celloidin) concerns quite a different process, the formation of limbs (BALINSKY [9])). While we do not wish to dismiss absolutely the possibility that competent gastrula ectoderm can form neural tissue in response to several kinds of stimulus, we favour the hypothesis that it reacts like other physiological systems which are sensitive to one chemical substance or to a limited class of chemical substances. A suggestive analogy arises from the fact that condensed polycyclic hydrocarbons can produce inductions; thus the sexual system of the mammal or bird is sensitive to one large group of such substances, being competent to produce a reaction of a specific kind (oestrus), while the skin of mammals in sensitive to another rather different group, reacting by tumour formation. Similarly it seems probable that the gastrula ectoderm is sensitive to some fairly large but limited group of similar compounds. We have recently suggested grounds for the hypothesis that the normal active substance of the living organiser may be a relative of these substances (WADDINGTON, NEEDHAM and BRACHET [3]).

We suggest that the word *Evocation* (NEEDHAM [3])) can be given several useful functions. In the first place, if we separate from "organisation" in general the concept of "regional determination" (SPEMANN [5])) or "individuation", we require a word for what is left. This was at one time called "induction as such" [2]) but is now spoken of as "evocation". Secondly, we give the name "evocators" to all substances which are known to stimulate gastrula ectoderm to neural differentiation, while thirdly we can speak of the substance which is active in normal development as "the evocator". Some grounds for preferring, instead of the word "activator", a specially invented word have been given above. But there is an additional reason, namely, that "the evocator" exists in the egg before gastrulation in a masked condition, from which it can be liberated by the action of heat or by less drastic treatments. We have used the term *Activation* to describe this liberation, and for this we suggest that it might well be reserved.

Finally, WOERDEMAN mentions that WEISS [10]) has critically discussed the organiser-problem and sharply formulated the objections also felt by himself, to the researches on chemical induction. WEISS's conclusion, however, was that WADDINGTON, NEEDHAM, and their collaborators had "noted the significant difference between live and dead organisers" and had "clearly distinguished between the 'evocating' activity of the inductor and the 'individuating' activity of the host field, all the organising, i.e. pattern-determining, effects going to the credit of the latter." "It appears", he concludes, "that this is the only stand one can safely take in view of such facts as have come to our knowledge so far" (p. 667). And with

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[9]) B. I. BALINSKY, Arch. Entw. Mech., **105**, 718 (1925).

[10]) P. WEISS, Physiol. Rev., **15**, 639 (1935).

this we agree save that such a formulation of the facts, like that of WOERDEMAN, fails to distinguish clearly between competence and individuation. WEISS's objections, in fact, were not directed against the theoretical considerations actually advanced by those who are studying "chemical induction" but against considerations which he was afraid might be advanced, or which are sometimes advanced by those who are not so intimately concerned with the subject.

We wish to express the hope that uniformity may soon be established with regard to the concepts and nomenclature used by workers on these phenomena, and we believe that for the present the three terms Competence, Evocation and Individuation, as we have defined them above, form a vocabulary adequately congruent with the facts at present known.

Comparative Physiology. — *Shape and slope of rest curves of the stretched foot of the snail (Helix pomatia L.) in relation to its water content.* (From the Laboratory of comparative Physiology of the University of Utrecht.) By N. POSTMA. (Communicated by Prof. H. J. JORDAN.)

(Communicated at the meeting of June 27, 1936).

JORDAN observed in his lengthening experiments that the foot muscle of hibernating snails is very dry and inclines to develop "contracture". He got the impression that this phenomenon could be prevented if the snail was allowed to take up water, creeping in a thin layer of water on the bottom of a vessel. This effect was to be expected, since JORDAN ascribed the resistance against extension to the viscosity of the foot muscle. The absorption [1]) of more or less water by the muscle will affect its viscosity. So it seemed useful to get more exact data concerning the relation between the water content of the foot muscle and its viscosoid tone (the slope of the length-time-curves).

Three series of extension experiments (HA 7—10 Febr., HB 10—13 Febr. and HC 11—14 Febr. '36) gave corresponding results, which confirm JORDAN's suggestion and support some points of view concerning the mechanism of the tonus phenomena, suggested in my thesis (1935*a*). The results will be described in this paper.

Experimental conditions.

After the epiphragma had been removed from about 14 hibernating

[1]) That is what JORDAN (1927) called "Hydratation" (German); in this paper the synonymous term "Hydration" is used for the adsorption of water by the colloidal particles of the muscle: the change of free into bound water. Consult, for the technical terms, my paper 1935*b*.

snails of the same weight, one half of them were kept on cabbage-lettuce, which was saturated with water, in a vessel covered with a glass plate; thus there was no loss of water by evaporation. In 64 hours the average weight of these snails increased with 27 %. The remnant of the group of animals was kept on lettuce in an aquarium, covered with wire netting; on an average the weight was unaltered. On the fourth day the viscosoid tonus of the foot muscles was measured by recording the rest curves during 10 minutes; then the foot was unloaded and the angles between an horizontal line and the tangent in the lowest point of the lengthening curves were measured, as well as the increase of length. After its extension the foot muscle was removed from the lengthening apparatus and weighed. Next the foot was cut in slices which were dried in a drying oven at 110° C. till the weight was constant. The decrease in weight is the loss of water.

Results.

Some curves are given in figure 1. If the statistical method is employed for the interpretation of the results obtained, the data must be selected

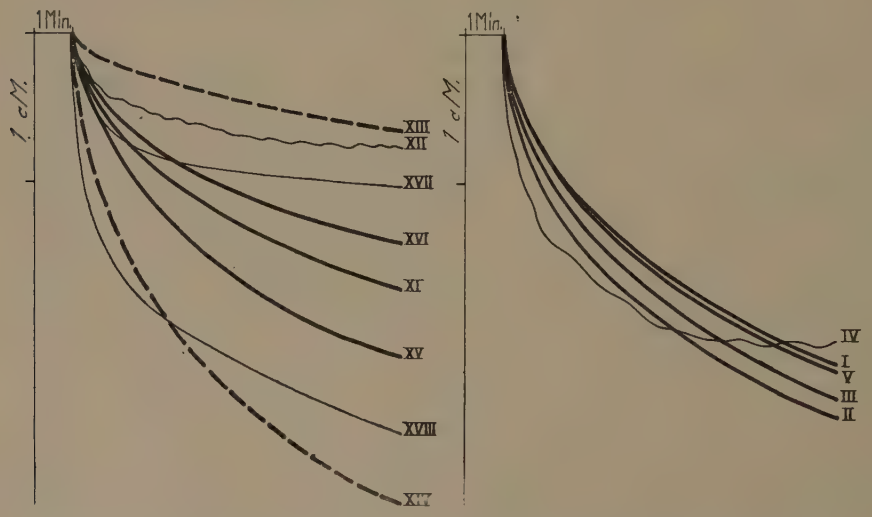

Fig. 1. Left part, composed after the results with respect to dry animals (of the three series), to demonstrate the different types of lengthening reaction. Right part gives the curves, obtained of the sodden snails of series HC.

critically. Therefore all myograms with spontaneous shortenings and contractions are left out of account (Series HA N°. IV and XII, HB N°. V, XV and XVII, HC N°. IV and XV). We only speak of a normal lengthening reaction if a greater lengthening-traject (ordinate) is regularly accompanied with a greater angle, measured at the end of the curves, these curves diverging fanshaped. A disturbance of 3° or more with respect to

the regular increase of the angle is taken as too strong a deviation (the angle has been estimated with an accuracy of $\pm \frac{1}{2}°$). Such curves are not of the normal type, no more than those that have a very steep beginning and change their slope by a sudden bend (curves XVII and XVIII fig 1), even when the angle does not derange the tabulated increase. In this way I selected out of 20 wetted snails 12 lengthening reactions which could be used and 7 out of 20 dry animals. The data are:

TABLE I.

	Body weight in gr.		Water content[2]		Lengthening in cm		Angle	
Series HA								
Watery snails	28		78.96%		1.81		$18\frac{2}{3}°$	
Dry animals	21		77.50		1.08		13	
Ratio		133		102		167		144
Series HB								
Watery snails	25		80.38		1.70		$16\frac{1}{2}$	
Dry animals	$20\frac{1}{3}$		75.85		1.40		13	
Ratio		123		106		121		127
Series HC								
Watery snails	$22\frac{1}{2}$		80.24		2.24		$21\frac{1}{2}$	
Dry animals	18		77.15		1.60		16	
Ratio		125		104		140		134
Average ratio		127		104		143		138

Discussion.

The water content found in the foot muscle of Helix agrees with the data of BELLION (1909) — 76.9—82.6 % —, like the alteration in weight by taking up water with that found by WEINLAND (1931): loss of water 2.01 gr, absorption 2.74 gr, average change in water content 4.75 gr.

If we compare the ratio of the data for sodden snails to that of dry animals — on the basis = 100 for the latter — the weight increases to 127[3]), the lengthening traject to 143, the angle of the extension curve to 138 and the water content of the foot to 104. Consequently the contrast between the slope of the curves and the increase of length is very great in proportion to the difference of the water content.

With respect to the body fluid in the foot of the snail, we have to distinguish:

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2) Percentage of the weight of the lengthened foot muscle.

3) After correction for the shell, which does not participate in the absorption of water, the ratio increases to 137.

I. the blood in the pedal part of the intestinal cavity;
II. the blood in the slits of the schizocoelic system;
III. the intracellular water, which is composed of the free water and that bound in the water-layer of the colloidal particles of the cells (hydration).

The viscosity of the foot will directly be determined by the ratio of the bound to the free water. Hydration is accompanied by increase of the water-layer at the cost of the free water. This change in the distribution of water will cause more resistance against lengthening: both the free water diminishing and the growth of the colloidal particles by the adsorbed water result in higher viscosity.

In control-observations the loss of blood was estimated. Foot and visceral mass were separated from each other over a watch-glass. Foot and the blood, escaping from the pedal part of the intestinal cavity, were collected on the glass. The foot muscle was transported to the lengthening apparatus and the glass with blood was weighed. The wetted snails gave 2—2½ × as much as the dry ones. (Portion I).

During lengthening and the treatment after extension the foot squeezes out blood and therefore loses water. The loss was estimated at 1¾ % of the weight of the fresh foot muscle (a part of portion II). The remaining part of the schizocoelic blood and the water content of the cells (portion III) together gave an average ratio of 104. The data obtained do not allow to know the ratio of free/bound water, decisive for the viscosity. But the fact that a difference of less than 4 % in water content is accompanied by a tenfold difference concerning the ordinate and the slope of the extension curves shows that the intake of water is of great importance for the viscosoid tone. This is in accordance with JORDAN's view. Obviously the water is chiefly absorbed in free state. The influence of the water content is accentuated if we restrict our attention to the sodden animals. Table II shows that a deviation in water content (the latter being relatively low) is accompanied by a small angle at the end of the lengthening curve.

TABLE II.

Series HA			Series HB			Series HC		
	Water content	Angle		Water content	Angle		Water content	Angle
No. I	78 %	9½°	No. V	79.8 %	4½°	No. II	78.55 %	17½°
IV	78.3	11½	VI	80	7½	III	78.9	17½
Middle types	79	18⅔		80.4	16½		80.2	21½

The blood in the intestinal cavity and that in the schizocoelic slits may also be of importance for the tonus level of the foot muscle. In the extension

myograms obtained of watery snails the ordinate of the normal types varies from 2.36 to 2.70 cm, the angle from 20 to 24°; this mutual agreement is in contrast with the diverging myograms got of dry snails: the ordinates range from 0.72 to 3.37 cm, the angles from 10 to 28°.

Three types of curves are to be distinguished in the normal myograms: curves VI, XV and XVI middle group; curves XIII and XIV extreme contrast, curve XIII hypertone, curve XIV hypotone. These types show different frequency in dry and wetted animals:

TABLE III.

		Dry snails	Sodden animals
Spontaneous		20%	15%
Normal reaction	Middle type	35	60
	Hypertone	15	5
	Hypotone	30	20

Recordingly the internal condition of the muscle is altered by the absorption of water, increasing the internal pressure: a well determined tonus level is better assured, which is lacking in the foot of snails in hibernation. This regulating principle is also evident from the fact, that in dry animals there is no correlation between a deviation of the angle from the middle type and a difference in water content, as it is in wetted snails (table II): a small angle is capriciously combined with different percentages concerning the water content. The responsible factor of this alteration must perhaps be sought in the extension exerted by the internal pressure, an effect to which the snail is exposed during every increase of contents (taking in food and absorbing water after rain showers). This suggestion is supported by the experience that the tonic condition of the foot of the snail may be altered by lengthening (POSTMA 1934 and 1935*a*): a foot that is poor in tonus becomes more tonic by applying it with a small load during a sufficiently long time-interval. So an extension exerted before a certain lengthening experiment unmistakably affects the result of this experiment. In this way the question arose if, during lengthening, the foot muscle reacts actively and therefore alters its properties. The increase of resistance in the rest curves during lengthening can simply be explained by mechanical effects, which occur also in plasticated rubber and other inanimate materials (JORDAN 1935*b*). Therefore it is impossible to prove here the alteration of the muscle's internal condition being of more than physical origin. Yet there are some phenomena, which support my suggestion that the muscle is reactive during lengthening:

1°. the activity of the dynamic component as soon as the equilibrium between static and dynamic tone is disturbed (my paper 1935*b*);

2°. the undulating slope of many extension curves (cf. POSTMA 1933, fig. 1 curve II);

3°. the fact that in the foot of the seahare the loss of tone, caused by cooling, is prevented by extension, when a load is applied (JORDAN 1935*a*).

The differences, occurring in spite of the same water content (XIII as well as XVI 78.2 %) have to be ascribed to a dynamic factor which we are not able to control (Similarly HC XVIII and XV with 79 and 78.8 % water, ordinates 1.16 and 2.40 cm; HA XII and XV with 78.7 % water, ordinates 0.84 and 1.74 cm).

I wish to thank Prof. H. J. JORDAN for his interest in this investigation and Mr. R. R. DE JONG for the correction of the text.

SUMMARY:

Absorption of water by the foot muscle of the snail results in lowering the tonus level (lower viscosity). Besides this it causes an equalization of the slope of the extension curves.

The increase of the slope and that of the ordinate of the length-time-curves are in perfect agreement with the intake of water, but are ten times as large as the increase of water content of the muscle itself.

The uniformity of the tonus level of watery snails is possibly related to the extension, exerted by the increase of the internal pressure, caused by the intake of water.

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b ———— Viscosity effects in the living protoplasm and in muscles. First report on Viscosity etc. Chapter VI. Verhand. Kon. Akad. v. Wetensch. Amsterdam afd. Natuurk. 1e sectie, **15**, 214—255.

a POSTMA, N., Onderzoekingen betreffende het herstel van de tonus bij de slakkevoet (Helix pomatia L.) enz. Thesis at Utrecht.

b ———— Tonus phenomena in the foot of the snail (Helix pomatia). Proc. Royal Acad., Amsterdam, **38**, 1036—1040.

Comparative Pathology. — *The heredity of the size and the form of the seeds of Phaseolus vulgaris. The segregation of the F_2-generation.* By G. P. FRETS. (Communicated by Prof. J. BOEKE).

(Communicated at the meeting of June 27, 1936).

In a first communication [1]) I have been able to state that the bean yields of the F_3-generation in my experiments represent various types, that some of them clearly resemble the I-line of the starting-material and others the II-line. This could be demonstrated by means of the characterogram.

The characterogram [2]) is the graphic representation in one curve of the examined characteristics with regard to each other for each individual or for the average of the total yield of a plant (or of the group or number chosen).

As an amplification of my first paper I will now point out that on application of this method it also appears that among the individual variations of the F_2-generation some correspond to the I-line and others to the II-line.

If of the various examined characteristics separate curves are made, this statement does not hold good. These curves merely show that the F_2-generation is more or less intermediate [3]).

In order to make a characterogram, a standard characterogram is needed. For the characteristics of this standard characterogram I take the average of the characteristics of the I- and II-line; for this standard material I prefer to take beans of the same year as those of which I want to make the characterograms.

Since this communication refers to material of the F_2-generation of 1934, the standard characterogram already published in my first communication may be used for the composition of these characterograms.

The characterograms for the I-line and for the II-line are very constant in form.

For the F_2-generation I made the characterograms of 67 beans from plant No. 63 and of 129 beans from plant No. 99. Plant No. 63 originates from a I $\times$ II crossing, plant No. 99 from a II $\times$ I crossing.

The F_2-generation after I $\times$ II crossings does not differ from that after II $\times$ I crossings [4]).

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1) Proc. Royal Acad. Amsterdam, Vol. **39**, p. 432 (1936).
2) Proceedings l.c. p. 432.
3) Genetica **17**, 1935, p. 62.
4) Genetica l.c. p. 54.

The characterograms are made in descending order according to the length. In fig. 2 some have been reproduced.

For plant 63, 16 characterograms have the form of that of the I-line; they are particularly met with among the long beans. Nine characterograms have the form of that of the II-line; these are found among the short beans. In the characterograms of the I-line [5]) length, breadth and thickness form a descending line, the weight lying high, the indices low. In characterograms of the II-line the line connecting length, breadth and thickness has a rising course, the weight lying low, the indices high (fig. 1).

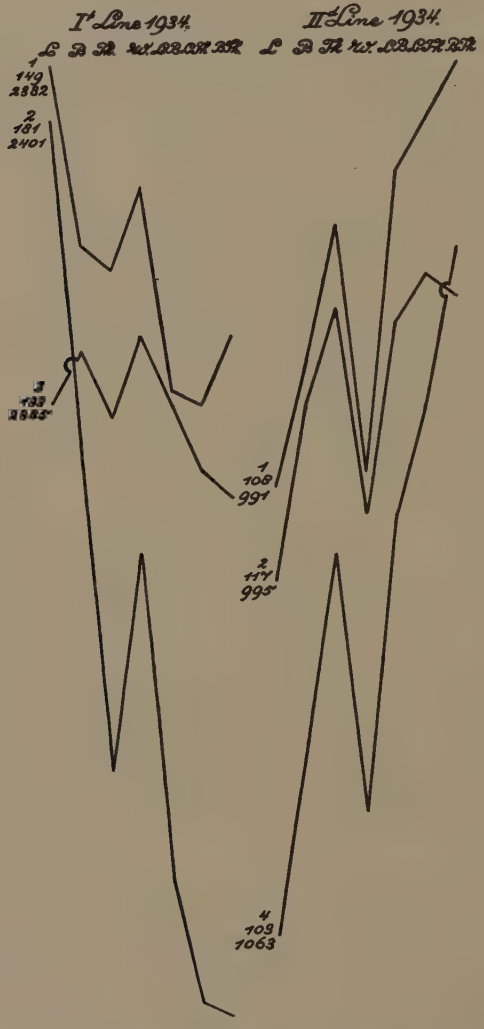
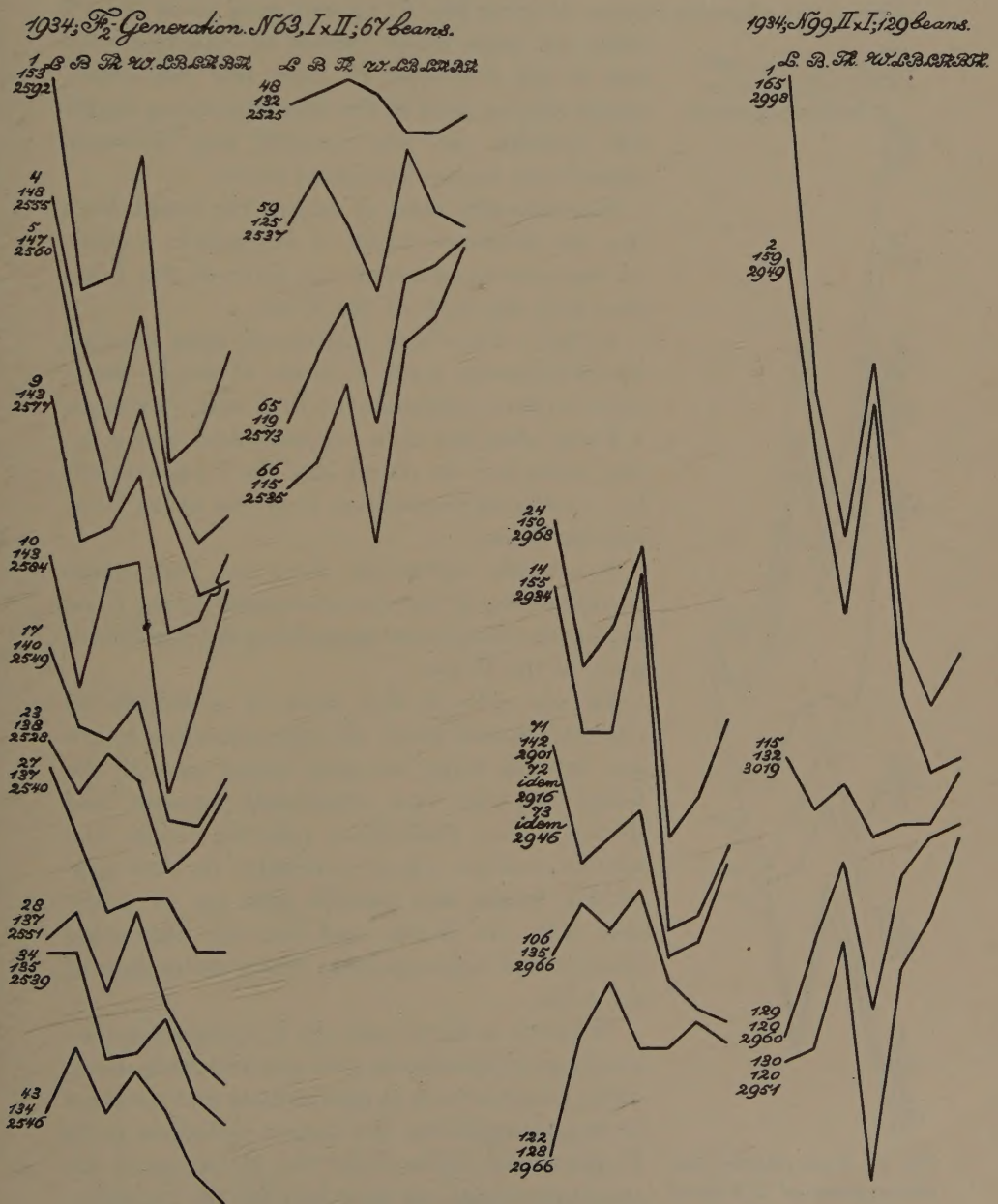


Fig. 1. Some characterograms of individual beans of the I-line and the II-line of generation 1934. On the left of each diagram its number, the length of the bean (in 0.1 mm) and the number of the bean are recorded.

[5]) Proceedings l.c. p. 434.

The remaining 42 characterograms of the beans from plant No. 63 have various forms. There are some where the line connecting length and breadth goes down, whereas the one connecting breadth and thickness rises; this happens in 27 cases. In 7 cases the line connecting length and breadth goes up and the one connecting breadth and thickness descends.



a, F_1 plant No. 63. *b*, F_1 plant No. 99.

Fig. 2. Characterograms of individual beans of the F_2 seed generation.

Of the characterograms made of 131 beans from plant No. 95, 46 have the form of the I-line and 10 that of the II-line. Of 57 characterograms the line connecting length and breadth goes down and the line connecting breadth and thickness goes up, and on the other hand of 8 characterograms the line connecting length and breadth goes up and the one connecting breadth and thickness goes down.

Among the characterograms of plant No. 63 as well as of plant No. 99 there are some which cannot be classified with one of the 4 groups. In these few characterograms one (or two) of the lines connecting length and breadth and also breadth and thickness respectively have a horizontal course.

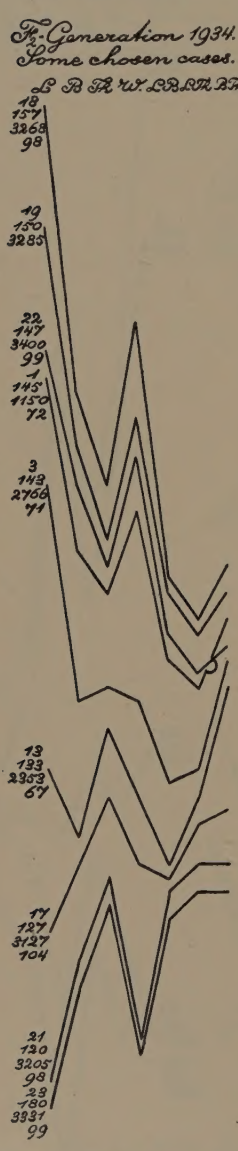


Fig. 3. Some selected characterograms of individual cases of beans of the F_2 seed generation.

Consequently there is among the beans from the two examined plants a far greater number of characterograms with the form of the I-line than with the form of the II-line.

In fig. 3 have been reproduced some selected characterograms made of beans of the F_2-generation of bean yields derived from other crossings.

From what has been communicated above the conclusion may be drawn that the F_2-generation has a different composition from that of the I-line and the II-line.

It contains variations; there are long beans corresponding to the characterogram of the I-line and others, short beans, resembling the characterogram of the II-line.

By the side of this there is a number of characterograms where the line connecting length and breadth takes the same course as with the I-line and the one connecting breadth and thickness runs similarly as with the II-line, and another number where, reversely, the line connecting length and breadth goes up, as is the case with the II-line, and the one connecting breadth and thickness goes down, as in case of the I-line.

Whereas in many cases the F_2-generation after crossings of individuals with characteristics which differ quantitatively is intermediate and it cannot be demonstrated that the various variations of the F_2-generation differ from the variations of the starting-material, we have here for the characteristics examined in the characterogram found a means to distinguish the variations of the F_2-

generation and to connect them in a conclusive manner with the parental forms of the starting-material.

In this way we shall have indicated the hereditary variations of the F_2-generation, which may be further corroborated by cultivation of the F_3-generation.